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VISCOSITY AND BAKING QUALITY

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General Discussion

The subject of gluten quality has been a moot point since the beginnings of cereal chemistry. Perhaps no other factor in flour quality has been more frequently, copiously, or heatedly discussed. If, as has been usual, the term is understood to be synonymous with baking quality, no other factor in flour quality is more important. Many men have worked upon this problem and the lines of approach have been many and varied, but no perfectly satisfactory definition or measure of this quality has as yet been found.

Probably the earliest method of arriving at the quality of gluten was that of actually washing it out and determining its characteristics by the sense of feeling. This method is still followed in many laboratories, and it is admitted that men trained in identical technique and working with the same water can report fairly concordant and significant results, in spite of the fact that the method itself depends upon many uncontrollable variables. Dill and Alsberg (1924), in their study of the gluten-washing problem, removed one of the most troublesome of these—that caused by the differences in the waters used. We who have tried the experiment of washing gluten from the same sample of flour in widely-separated laboratories have had the fact impressed upon us that the water used is a highly variable factor, and one whose importance is not generally recognized. If we are to continue washing glutens, we should by all means standardize upon "Dill and Alsberg's solution" as the washing medium.

Another variable which has been attacked is that of reliance upon the use of the sense of feeling to determine values and upon descriptive words to record them. Various devices have been used to determine and record mechanically certain properties of the wet gluten.

However, there are left other variables—one of which is the inability of two operators to check each other, qualitatively or quanti-

tatively, unless they have been trained in identical technique—which are at present uncontrollable and which make washing unsatisfactory as a general method for the determination of the quality of gluten.

Of late the viscosity determination has received much attention, and it is the relation of this factor to the results secured by baking with which this paper is to deal. Two schools of thought are apparent concerning this subject. One school apparently studies, as an abstract research problem, the quality of the gluten itself, apart from any consideration of its environment—ignoring the fact that bakers regard the term "gluten quality" as synonymous with "baking quality." Gortner (1924), an able exponent of this school, arguing from his own work and from that of Rumsey (1922) and others, goes so far as to state that the baking test should be ruled out as a reliable index of gluten quality.

The second school of thought holds that any method of determining the quality of gluten in any flour succeeds or fails in direct ratio to the accuracy with which it checks up with the performance of that flour in the oven. It contends that baking quality, and not gluten quality, is the all-important factor if the two qualities are to be regarded as separate individuals. Most men in charge of flour-mill laboratories belong to this second school. They know that the final judgment of their work rests with the jury of bakers who try their flours, and that no matter how perfect the quality of the gluten of any flour may be, taken as gluten apart from any other consideration, it will be declared of poor quality if it does not perform satisfactorily in the oven. It is from the standpoint of this second school of thought that this work was done.

A summation and study of the routine viscosity and baking results on file in the laboratory seemed to indicate

1. That in short patent bread flours the viscosities were comparatively high and were in reasonable agreement with the baking qualities of the flours.
2. That in 95% straight flours, or so-called "standard patents" or "long patents," the viscosities were markedly lower than those of the short patents, while the average baking quality, as shown by loaf volume, break, grain, and texture, was equal, if not superior to the average of the short patents.
3. That in clears and low grades the results were contradictory and inconclusive.

These generalizations were based upon routine determinations, made by several different men, without the precautions desirable in precise work. In addition, the work was done on flours of both known

and unknown history, by the use of several different types of instruments, and extended over a long period of time, with consequent variations in environment and technique. For these reasons it was considered advisable not to report here the data referred to above, but to study more intensively a limited number of flours, covering a wide range of viscosity and baking quality, and of known grade, origin, and history.

Several types of viscosimeters are available for the study of flour. All the viscosity work of the writer has been done in instruments of the flow type. In the earliest investigations an ordinary pipette was used, with indifferent success. Next was tried a pipette with a short capillary outlet. This worked better, but there were some inconsistencies due to the fact that the viscosities of some of the suspensions were below that necessary to insure viscous instead of turbulent flow. When Sheely (1923) described the pipette used in his work on glue one of these instruments was secured. Being of the long-outlet type, the velocities of flow of the least viscous suspensions studied were found to be well below the critical velocity, and the data so far secured have not revealed any internal evidence of serious error.

While no attempt has been made to determine whether or not the objections of Sharp and Gortner (1923) to the Ostwald type of viscosimeter apply to the Sheely pipette, it is believed that the conclusions drawn from this study will be substantiated, no matter what style of viscosimeter is employed.

Flours Used

The flours used in this study were milled from wheat mixtures made up from known wheats, either by the writer or by a member of this association in whose work implicit confidence is placed. They are described as follows:

Flour No. 1. Strong short patent spring wheat flour made from dark No. 1 northern spring wheat, selected for high protein and high viscosity.

Flour No. 2. Strong clear spring wheat flour made at the same time as Flour No. 1.

Flour No. 3. Strong low-grade spring wheat flour made at the same time as Flours Nos. 1 and 2.

Flour No. 4. Medium strength 95% straight blended-wheat flour made from a blend of 70% dark No. 1 and dark No. 2 northern spring wheat and 30% dark No. 2 hard winter wheat.

Flour No. 5. Medium strength low-grade blended-wheat flour made at the same time as Flour No. 4.

TABLE I
RESULTS OF CREAMICAL ANALYSIS OF FLOURS, AND DETERMINATIONS OF VISCOSITY OF FLOUR SUSPENSIONS

	Flour No.	1	2	3	4	5	6	7	8	9	10
Moisture	12.70	11.53	12.70	13.27	12.95	13.00	12.82	12.27	11.17	10.60	
Ash	0.443	0.636	1.153	0.432	0.903	0.439	0.866	0.423	0.705	1.081	
Protein	12.12	13.96	14.29	11.54	13.68	10.46	11.48	10.42	11.68	13.00	
Viscosities	9 gm.	36	34	26	33	26	31	24	31	28	
Electrolytes	12 "	51	45	29	47	28	40	26	42	34	
Present	15 "	79	66	36	72	32	56	32	62	30	
Seconds	18 "	127	100	48	118	38	88	38	46	35	
Av. slope of line	21 "	211	143	56	197	49	137	49	164	46	
Viscosities	9 gm.	34	39	35	33	38	30	30	31	32	
Electrolytes	12 "	68	76	58	59	73	49	49	49	49	
Removed	15 "	164	172	119	132	171	85	88	109	107	
Seconds	18 "	445	340	252	230	369	200	157	230	182	
Av. slope of line	21 "	1518	1135	488	378	507	372	308	552	161	
Bread score at various fermentation periods	1 hr.	98	88	76	96	77	96	78	86	60	
	2 "	99	98	97	96	98	92	91	94	63	
	2½ "	99	98	97	99	95	92	89	86	72	
	3 "	99	98	87	89	97	90	96	83	74	
	4 "	98	89	96	88	89	85	94	79	67	
	5 "	94	71	96	88	89	81	90	76	63	

Flour No. 6. Weak 95% straight blended-wheat flour made from a blend of 30% dark No. 2 northern spring wheat and 70% semi-dark hard winter wheat.

Flour No. 7. Weak low-grade blended-wheat flour made at same time as Flour No. 6.

Flour No. 8. Weak short patent hard winter wheat flour made from hard winter wheat.

Flour No. 9. Weak clear hard winter flour made at the same time as Flour No. 8.

Flour No. 10. Weak low-grade hard winter flour made at the same time as Flours Nos. 8 and 9.

A summary of the analytical data obtained is given in Table I.

Viscosity Methods

(a) Electrolytes present. Weigh out portions of 9, 12, 15, 18, and 21 grams of the flour into 400-ml pyrex beakers. Add respectively 100, 98, 96, 94, and 92 ml distilled water at 20° C. Beat with a turbine egg whip until homogeneous suspensions are secured. Add 5 ml N lactic acid and beat again. Hold in thermostat at 20° C. for approximately 15 minutes. Stir thoroly and pour into Sheely pipette clamped in a vertical position. Adjust level of liquid (foam line) to upper line of pipette and read with a stop watch to the nearest second the time of emptying to the lower line.

(b) Electrolytes removed. The method of Gortner (1924) was used in preparing the samples, with the following modifications: (1) One more leaching with 500 ml of distilled water was made, (2) the work was done at as nearly 20° C. as possible, and (3) samples of 9, 12, 15, 18, and 21 grams were used in each case. Viscosity was determined as outlined above.

Baking Method

The baking method used was substantially that employed in routine baking in the laboratory, except that fermentation tests were run with each dough and that six two-loaf batches were run from the same flour at once. The fermentation periods were from one to five hours on each flour, in order to secure information as to the relative stability and optimum fermentation period of each flour. The formula used was

Flour	800 grams
Water...To standard consistency, as determined by preliminary batches	
Sweetened condensed milk.....	80 grams
Salt	12 grams
Yeast	24 grams
Shortening	12 grams

The temperature of the water was so adjusted as to bring the doughs out of the mixers at approximately 80° F. The doughs were mixed for three minutes in Bachman mixers. An amount containing 100 grams of flour was scaled from each dough for fermentation tests in 1000-ml Chidlow jars, and the doughs were rounded up and placed in bowls in the fermentation cabinet at 90° F. and approximately 70% relative humidity. It may be mentioned here that the results of the fermentation tests were meaningless so far as the writer was able to discover, and they are not reported or considered in this paper.

The total time of fermentation was divided into four periods—60% to the first punch, 20% to the second punch, 10% to the third

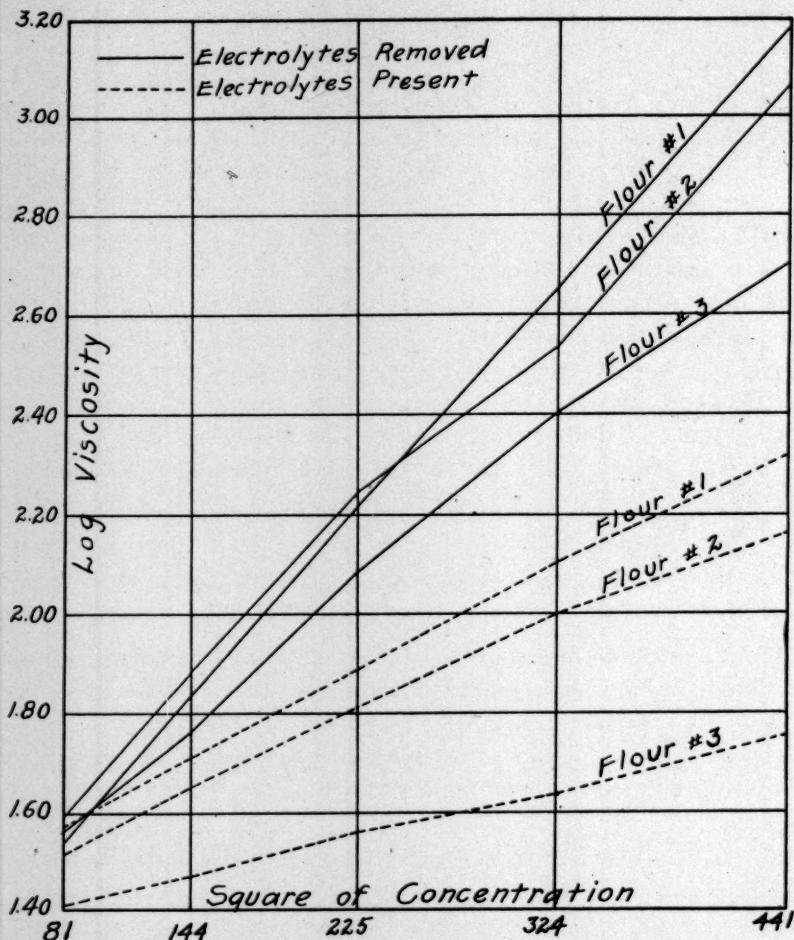


Fig. 1. Relation Between Logarithms of Leached and Unleached Viscosities (in Seconds) and Square of Flour Concentration in Strong Spring Flours

punch, and 10% to the bench. At the end of the fermentation period each dough was divided into two equal portions, which were then molded into loaves and placed in the pans. The pans used were those furnished by the Industrial Appliance Company to accompany their hour-glass type loaf-measuring apparatus. Each loaf was left in the proof-box at 90° F. until its highest point was just above the level of the top of the pan, when it was baked for 35 minutes at 410° F. in a

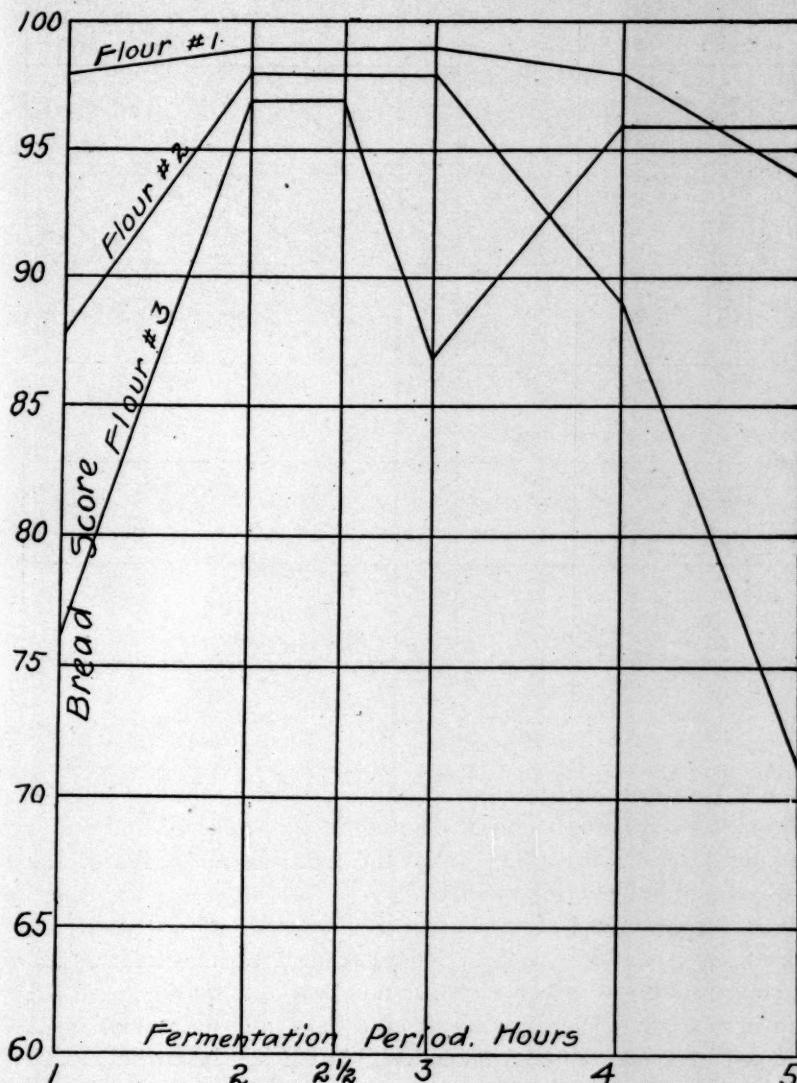


Fig. 2. Relation Between Bread Score and Fermentation Periods (in Hours), in Strong Spring Flours

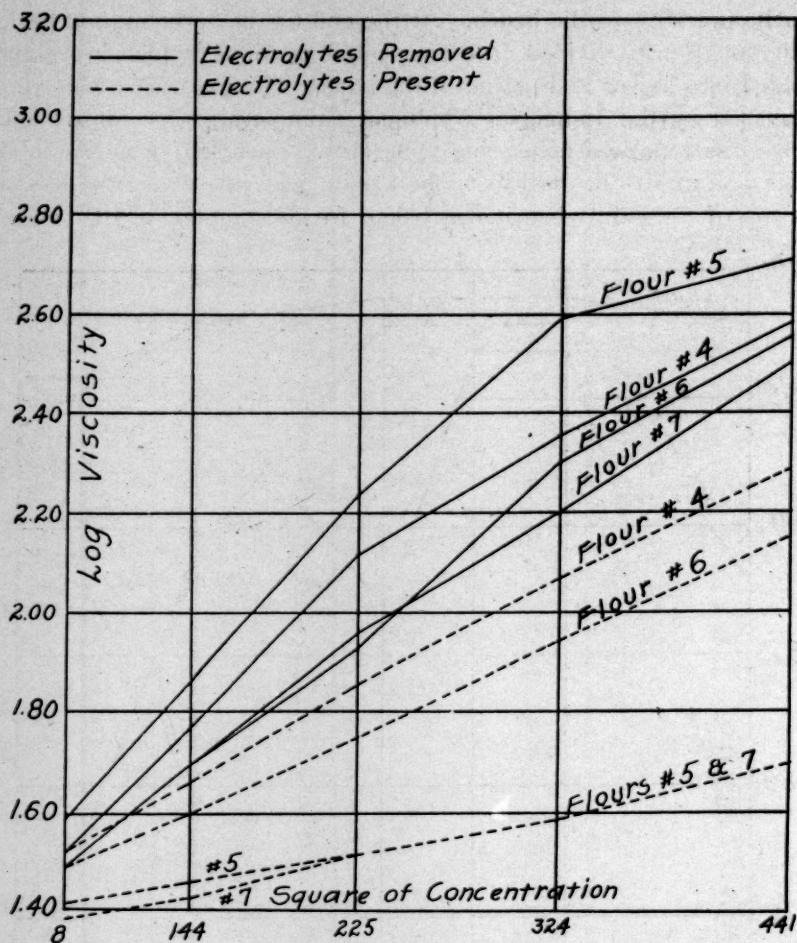


Fig. 3. Relations Between Logarithms of Leached and Unleached Viscosities (in Seconds) and Square of Flour Concentrations in Medium and Weak Blended-Wheat Flours

No. 100 Despatch oven equipped with a six-heat control—three heats each on top and bottom units. The bread was weighed and measured one hour after baking. The following morning all loaves of the set were cut and judged for quality.

The foregoing baking technique is the result of ten years' study. It produces a loaf of bread of most excellent eating quality, and one characterized by a rather large volume without marked sacrifice of grain or texture. The high break upon one side of the loaf has been criticized by some as "unsymmetrical," but it has been the experience of the writer that the height and smoothness of shred of this type of break, taken in connection with the loaf-volume obtained and with the

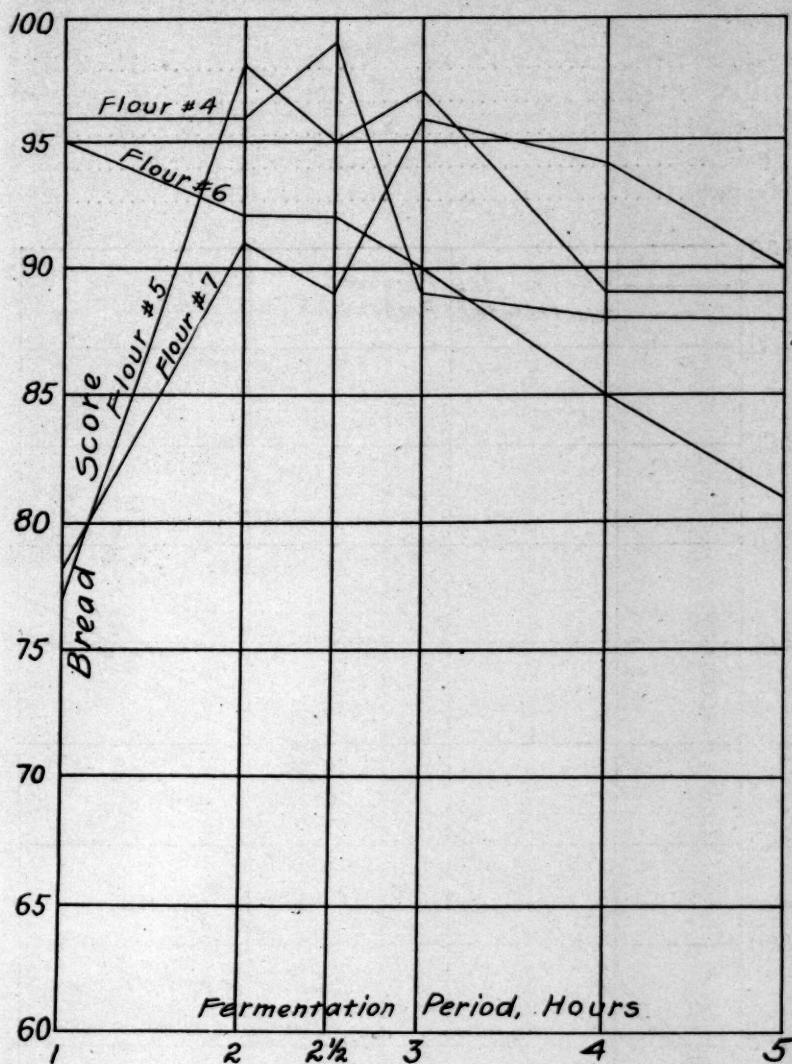


Fig. 4. Relation Between Bread Score and Fermentation Periods (in Hours) in Medium and Weak Blended-Wheat Flours

grain and texture of the crumb, give the clearest idea of baking quality of any baking procedure which he has yet tried.

The system of bread scoring adopted for this work was entirely different from that in regular use in the laboratory, as baking quality apart from any consideration of color or flavor was the factor being

measured. The factors used, with their relative weights, were as follows:

Volume	25%
Height of break.....	20%
Shred of break.....	20%
Grain	20%
Texture	15%

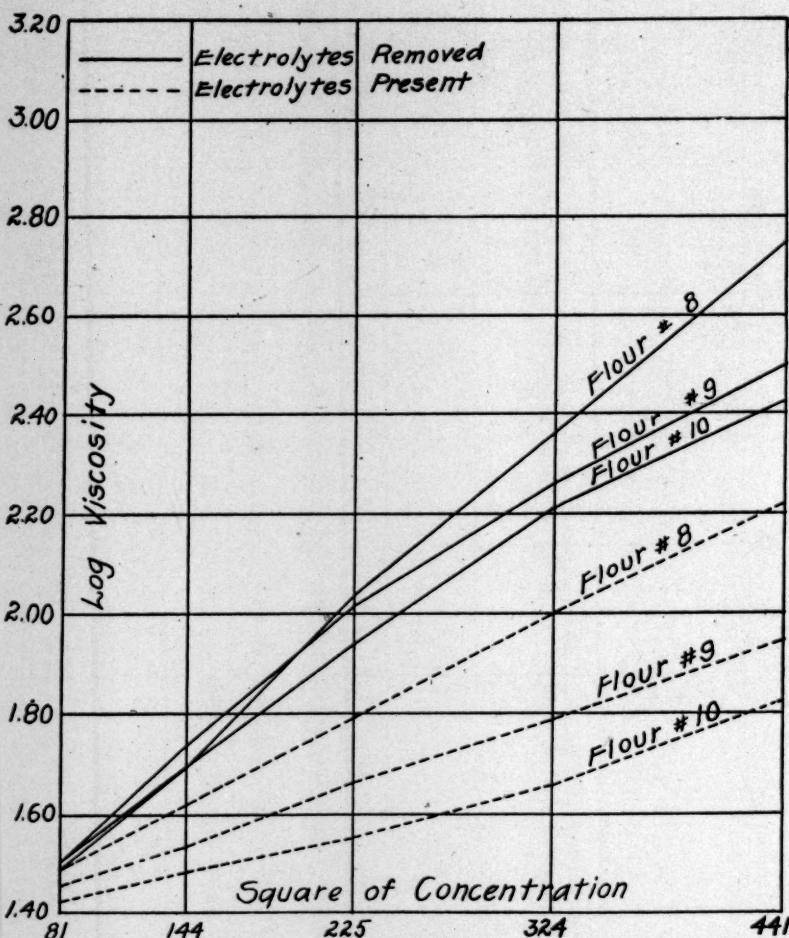


Fig. 5. Relation Between Logarithms of Leached and Unleached Viscosities (in Seconds) and Square of Flour Concentrations in Weak Hard Winter Flours

Analysis of Results

In plotting the viscosities against concentrations it was found that the method of Gortner, applicable to torsion viscosimeters, does not apply to the results obtained by the use of a Sheely pipette. A con-

sideration of the mechanics of the two types of instruments, however, led to the conclusion that in the case of the Sheely pipette the logarithms of the viscosities, in seconds, should approximate a straight line when plotted against the square of the flour concentration, and this was the method of plotting adopted. It will be seen from Figures 1, 3, and 5, however, that the lower grades of flour tend to form curves, decreasing in pitch with increasing flour concentration in the

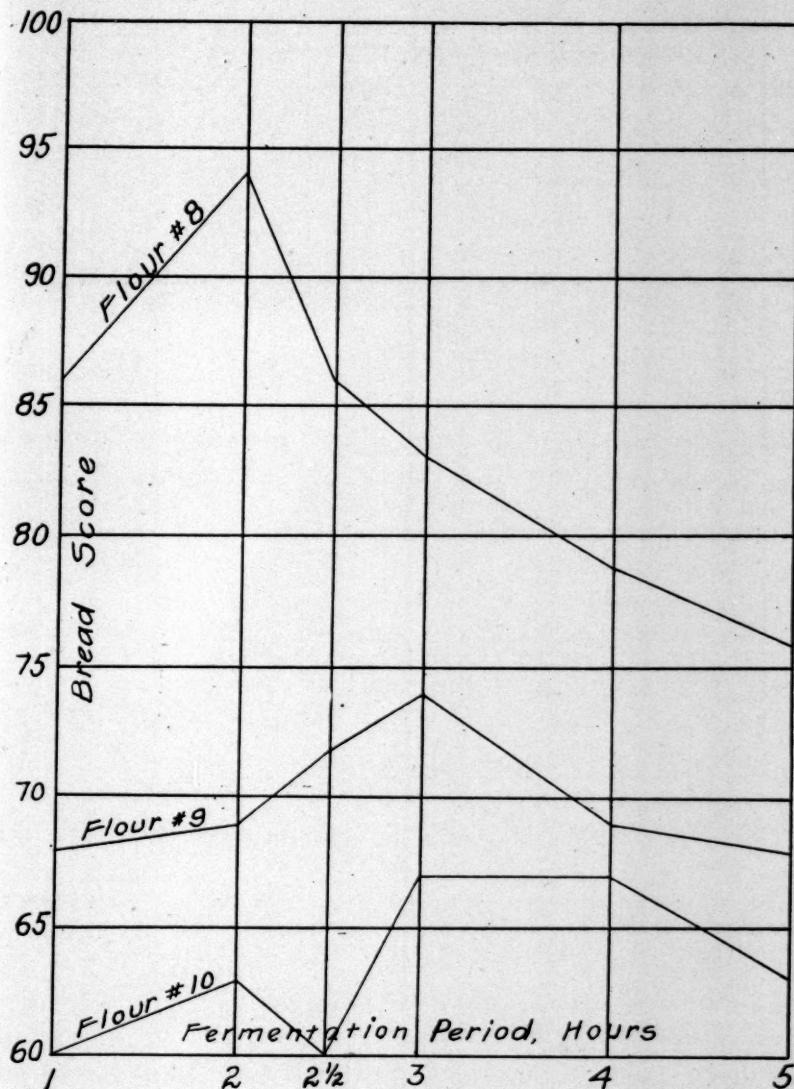


Fig. 6. Relation Between Bread Score and Fermentation Period (in Hours) in Weak Hard Winter Flours

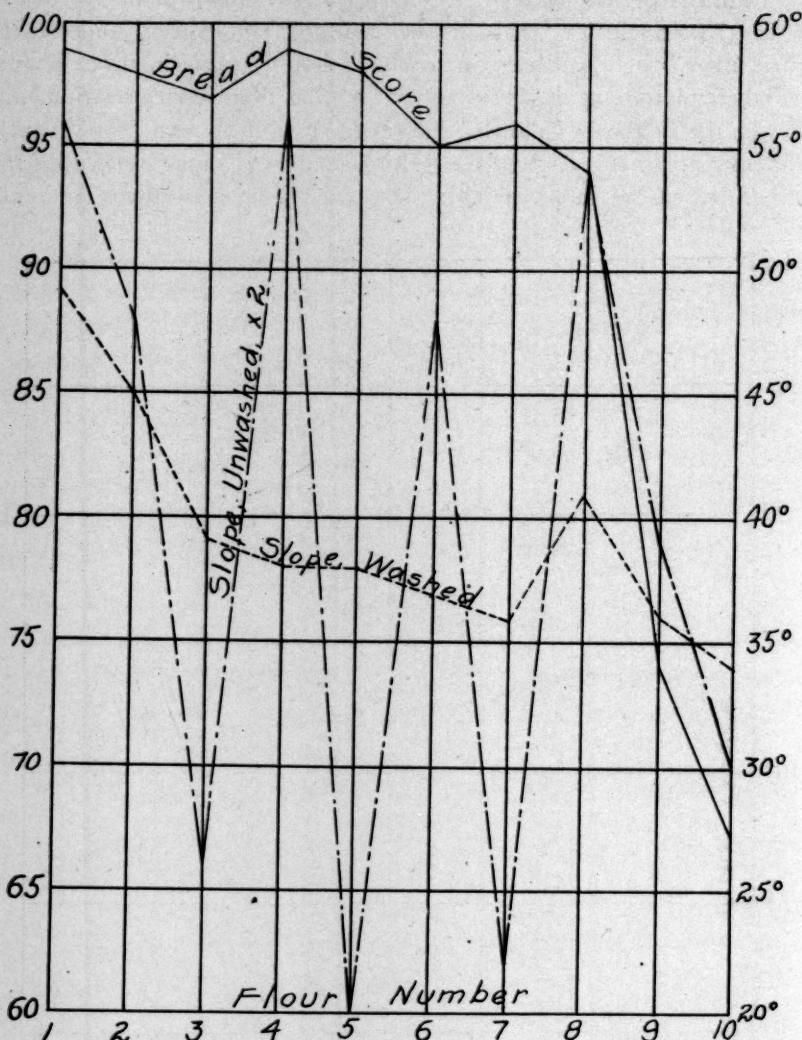


Fig. 7. Summary of Relations of Bread Score and Slopes of Leached and Unleached Viscosity Curves

electrolyte-free condition and, to a much lesser degree, increasing in pitch with increasing concentration when the viscosity is determined upon the flour without leaching out the soluble constituents.

An inspection of Figures 1 and 5, covering the very strong spring and very weak winter flours, respectively, shows that in each case the curves lie as would be expected. The washed viscosities have much steeper slopes than the unwashed, but point to the same conclusions. In both spring and winter flours and by both methods of viscosity

determination it is seen that the patents have the steepest slopes and the low-grades the flattest; the clear grades occupying intermediate positions. If these lines mean anything at all, Figure 1 conveys the impression that flour No. 1 should be markedly superior in baking quality to No. 2, and greatly superior to No. 3. Similarly, and to approximately the same extent, flour No. 8 should surpass No. 9 and No. 10, as shown in Figure 5.

Figures 2 and 6, showing the baking qualities of these flours at varying periods of fermentation, bear out these findings only in part. It is seen from Figure 2 that all the strong spring flours yielded excellent and very similar loaves of bread, the difference in scoring between 97 and 99 being almost within the limit of error. These results are not at all those anticipated from the viscosity results. Figure 6, however, is in very good agreement with Figure 5; showing as it does that the weak hard winter patent attained a maximum score of 94, while the clear reached only 74, and the low-grade made the very poor showing of 67 as a maximum bread score. These differences are much greater than any possible error in judging the loaves.

A study of Figures 3 and 4, dealing with the medium and weak blended-wheat flours, shows highly contradictory results. The straight flour, No. 4, shows only a slightly higher maximum bread score than does its low-grade, No. 5; whereas the weak blended-wheat straight, No. 6, has a maximum score slightly lower than that of its low-grade, No. 7. These tests were repeated until there was no doubt that the curves present the actual conditions obtaining in the case of these particular flours. Neither the washed nor unwashed viscosities indicated any such relations in the baking qualities as those actually observed.

In an attempt to clarify further the results of this work, many other charts were prepared, in which each factor was plotted against every other factor to which it could be related. All these charts showed the same lack of agreement. The plainest and most significant of these is given here as Figure 7. In it the slopes of the curves (the unwashed viscosity slopes being multiplied by two to avoid a separate scale) are plotted against the maximum bread score of each flour. It will be seen from this figure that the variation of the viscosity curves from flour to flour is in very poor agreement with the variation of the baking quality.

Conclusions

1. Viscosities determined by leaching out the soluble constituents do not seem to possess any more merit in indicating baking quality than do those determined upon the flour without such leaching.
2. All flours of high viscosity have been found to be of excellent baking quality. Flours of low viscosity have been found to range from excellent to poor in baking quality. Viscosity is therefore not a measure of baking quality, except possibly in the case of short and standard patents, within each of which grades there seems to be some correlation between viscosity and baking quality.

Acknowledgment

The writer wishes to acknowledge the collaboration and assistance of Mr. LaVerne E. Sleeper in securing the data presented in this study.

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VISCOSITY STUDIES WITH NEBRASKA WHEAT FLOURS¹

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That variations in flour strength might be attributed to differences in colloidal properties of the various glutens was first pointed out by Wood (1907), and one of the prominent features of the more recent research in cereal chemistry has been the application of modern principles of colloid chemistry to the complex problem of flour strength. The most conspicuous development from recent work along this line is Sharp and Gortner's (1923) well known viscosimetric procedure for measuring gluten quality. The procedure is based upon the belief that, other things being equal, "strong" glutens will have higher hydration capacities and will imbibe water (become hydrated) more rapidly than "weak" glutens. These differences in hydration capacities are considered to reflect inherent colloidal differences in the various glutens, and there is strong evidence that glutenin is the protein which is in all cases responsible for variations in colloidality.

Since the viscosimetric procedure advocated by Sharp and Gortner has seemed to offer a useful means of evaluating gluten quality in wheat and flours of unknown strength, industrial and cereal chemists have eagerly sought to make practical use of the idea. It should therefore here be emphasized that although Sharp and Gortner have advocated viscosity merely as a measure of *gluten* quality, the practical industrial chemist is interested in gluten quality only as it affects actual *baking* strength. In the majority of cases, therefore, the industrial chemist has apparently attempted to interpret his results in terms of baking quality. This is to some extent justified, since gluten quality is generally considered to be the most important factor affecting baking quality, providing the *quantity* of gluten is sufficient. The finished loaf is still the best known evidence of quality in gluten, and *loaf volume*, under comparative conditions, is the only important "strength" factor which may be measured and expressed in absolute terms. In the majority of attempts to correlate viscosity with baking quality, the procedure has been modified to suit the respective tastes and inclinations of the individuals concerned. Some industrial cereal chemists have stated in private communications that they have found the vis-

¹ Published with the approval of the Director as Paper No. 11, Journal Series, Nebraska Agricultural Experiment Station.

cosity test to serve a useful purpose in routine laboratory work. Others report absolute failure to derive any reliable information from such applications of the test as they have been able to make. The only published accounts² of practical results obtained from the *routine* use of the principles involved in Sharp and Gortner's procedure (insofar as the writers are aware) are by Weaver and Goldtrap (1922) and by Morgan (1924), who reported that his attempts to make useful application of the viscosity test were decidedly successful, and that his method of procedure materially assisted the mill in manufacturing a flour of uniform quality. Weaver and Goldtrap (1922) used viscosimetric procedure to assist them in estimating the proper absorptions and fermentation periods for certain flours.

Gortner (1924) has definitely specified a viscosimetric procedure which he believes will give the most reliable indication of gluten quality. For the purposes of this paper, the technical details need not be discussed here. This procedure calls for preliminary removal of electrolytes by alternate suspensions and decantations with distilled water. It also emphasizes the necessity of recognizing that viscosity values will be influenced by the quantity as well as by the quality of protein. Therefore several determinations are advocated, using a different flour concentration in each case. When the logarithms of the viscosities are plotted against the logarithms of the flour concentrations (using the latter as ordinates) the values lie on a straight line, the *slope* of which indicates the quality of the gluten. This factor may be expressed numerically as the tangent of the angle which this line makes with the horizontal and is designated as "constant b." Apparently this was not intended as a general routine laboratory procedure suitable for industrial purposes, for the time and details involved prohibit consideration of it as a practical method for the average industrial chemist.

Various short-cuts and modifications of the method prescribed by Gortner (1924) are in use, although it is impossible at this time to estimate their value; in fact little has been published concerning them. Only a few of the more obvious modifications of the procedure will be dealt with in this paper. There are, of course, two features of Gortner's specifications which, as Gortner himself recognizes, seriously interfere with its use in practical routine work. First, there is the possibility of omitting (as most flour chemists do) the preliminary removal of electrolytes. The elimination of this step saves time.

² Since this went to press, there has appeared a paper by Luers and Schwarz (1925), in which a definite relationship between viscosity and baking value is reported. These investigators, however, heated their flour suspensions to a degree that their viscosity data probably reflect properties of starch rather than gluten.

Moreover, many feel that since the electrolytes are natural flour constituents and are present in the bread dough they should also enter into the viscosity determination. It may be supposed that this procedure would not seriously interfere with *comparative* values only where flours of the same grade or ash content are under examination, or where effect of varying mineral content may be otherwise properly accounted for. This assumes that flours differ in *amount* rather than in *kind* of electrolytes, which probably is usually, but not always, true. Johnson and Bailey (1924) found that constant "b" of a leached flour frequently differed greatly from that of the same flour when unleached. The other practical consideration is, of course, the desirability of obviating the necessity for making several viscosity readings at different flour concentrations, as advocated by Gortner (1924), in order to eliminate the factor of *quantity* of protein as affecting viscosity measurements. Is there any way in which a *single* viscosity determination can be used as a basis for even *approximately* estimating gluten quality? Since starch is not considered to seriously influence viscosity readings with acidified flour suspensions, it has been suggested that, knowing total protein and moisture content, samples may be prepared so that all contain the same *amount* of protein. It has also been suggested that viscosity readings may, for practical purposes, be reduced to a common protein basis by dividing the viscosity reading by the protein content of the flour. It should be remembered, as Gortner (1924) points out, that "it is probable that the glutenin content and not total protein content is actually the *quantity* factor. There is, however, some evidence that the ratio of glutenin to total protein does not vary as widely as has been supposed so that, for rough calculations, the total protein content may be used." It is possible, however, to question the necessity of putting viscosity values on a quantity basis where viscosity results are to be compared with loaf volumes. It is true that the factor of protein quantity enters into viscosity measurements, but does it not influence loaf volume as well? If viscosity values must be put on a common protein basis, why should not the same be true of loaf volumes? Since the quantity factor affects *both* viscosity and loaf volume, it may be well in most instances to disregard it entirely.

Experimental

During each of the past three years, this laboratory has attempted to make a fairly comprehensive "survey" of the Nebraska wheat crop for each season, from the standpoint of composition and especially milling and baking quality. There was found to be considerable variation among the samples of each year, respectively, and that in a large

number of instances this variation could not be attributed to differences in protein content. The surveys made available a large number of samples of flours of widely different baking strengths. It was felt that the samples showed a wider range of variation than would probably be encountered among samples from carlots of wheat purchased by any commercial mill in the course of a year's run, since mills attempt insofar as possible to purchase wheat of uniform and known quality. It was considered that viscosity tests on a number of these samples should be of interest from several viewpoints. Could the observed variations in baking strength be attributed to differences in gluten quality, or were they probably due to some other factor? What information could be obtained from attempting to apply the underlying principle of the viscosity test to a large number of hard winter wheat samples of known origin and baking strength? Could the test be shortened or modified for routine purposes without too serious a loss of accuracy?

In order to attempt to answer the foregoing and other questions, as well as for the purpose of becoming familiar with the viscosity test and arriving at an estimate of its value as a measure of baking quality in Nebraska wheats, the following experiments were conducted:

One hundred ten flours of known baking strengths were selected from the 1922 survey. The loaf volumes of the samples ranged from approximately 1600 to 2400 cc. and the protein contents from 9 to 17 per cent. First, a single viscosity reading was made in the case of each flour, without previous removal of electrolytes, using 25 gm. of flour to 98 cc. of distilled water and 2 cc. of 85 per cent lactic acid. The MacMichael viscosimeter with a plunger 2 cm. in diameter, and a certified No. 30 wire was used. The speed of the turn table was 19.5 R. P. M. Next, a similar series of single viscosity readings was made, but in this series all samples were uniformly treated with several applications of distilled water to remove electrolytes. These two series of results were subjected to statistical analysis and the coefficients of correlation for loaf volume (expressed in cc.) and viscosity (in degrees MacMichael) were computed in each case. Since the probable effect of variations in protein content on viscosity values was not accounted for in the procedure used, an attempt was made to correct for this factor by dividing the viscosity reading of each flour by its protein content. This was done for each series, and coefficients of correlation were again computed. This established correlation between loaf volume and the ratio of viscosity to total protein, both with and without preliminary removal of electrolytes. The correlation between total protein in the wheats of this series and loaf volume was computed, as well as the correlation

between protein content and viscosity (at one flour concentration with electrolytes removed). These correlations are all shown in Table I.

TABLE I
COEFFICIENTS OF CORRELATION

No. of samples	Factors correlated	Coefficient of correlation	Probable error
110	Loaf volume and actual viscosity (unleached).....	+0.245	± 0.060
110	Loaf volume and actual viscosity (leached).....	+0.187	± 0.062
110	Loaf volume and actual viscosity divided by total flour protein (unleached).....	+0.150	± 0.063
110	Loaf volume and actual viscosity divided by total flour protein (leached).....	-0.023	± 0.067
112	Loaf volume and protein content of wheat.....	+0.304	± 0.058
110	Protein content of flour and actual viscosity (leached) ..	+0.654	± 0.037

Since, as will be shown in the table and discussion which follows, the results of the experiments just outlined were somewhat out of line with what was anticipated, it was decided to select a group of flours for detailed study, following as closely as possible Gortner's (1924) specified procedure in every particular. For this work 19 flours were selected from samples accumulated during the course of the 1923 crop survey. These samples were arranged in groups according to protein content, each group being composed of flours of approximately the

TABLE II
APPLICATION OF GORTNER'S (1924) SPECIFIED VISCOSITY PROCEDURE TO 19 SELECTED FLOURS

No.	Variety	Flour protein	Glutelin	Loaf volume	Con- stant "b"	"Constant "K" in 10 gm. flour	Diastatic value maltose produced
							Milligrams
Group 1 ... {	541 Kanred	8.3	3.06	1700	3.08	.0055	25
	403 Turkey	8.6	3.08	1750	1.65	.0029	60
Group 2 ... {	580 Nebraska 6	8.8	2.28	2050	2.34	.0026	28
	530 Kanred	9.1	3.59	1790	2.19	.0044	52
Group 3 ... {	533 Nebraska 6	9.2	3.48	2240	2.58	.0040	34
	523 Kanred	9.4	3.58	1770	2.30	.0047	61
Group 4 ... {	521 Turkey	9.4	3.52	2050	2.19	.0032	168
	421 Kanred	10.1	4.02	1820	2.60	.0057	23
Group 5 ... {	450 Kanred	10.4	4.10	1750	2.25	.0053	37
	422 Kanred	10.6	4.06	2270	2.05	.0037	28
Group 6 ... {	451 Turkey	10.6	4.05	2020	1.70	.0034	30
	402 Java	11.6	4.14	2240	2.14	.0040	50
Group 7 ... {	425 ?	11.8	4.43	1770	2.14	.0054	80
	571 Durum	12.0	4.20	2120	2.47	.0049	51
Group 8 ... {	453 Kanred	12.8	5.13	1720	1.87	.0056	?
	554 Nebraska 60	13.0	4.55	2700	2.45	.0041	24
Group 9 ... {	562 Nebraska 60	13.4	4.66	2680	2.14	.0038	18
	560 Kanred	13.7	5.16	1920	2.61	.0070	27
Group 10 ... {	599 Polish	13.0	3.97	1300?	4.45	.0137	?

*Glutelin \times "b"

Loaf volume

same protein content, but of different baking values. The diastatic value³ and glutenin content of each flour was also determined, the latter by the method of Blish and Sandstedt (1925). The results of this study are presented in Table II.

All samples in any series of experiments here presented, were milled on an Allis-Chalmers experimental mill. Judging from the percentages of ash in the various samples (averaging around .41) the milling was fairly uniform. The baking formula involved the use of 4.6 per cent yeast with an equal amount of sugar. This baking formula will be criticized by some on account of the large amounts of yeast and sugar used. It has been found in this laboratory, however, that it gives as comparable and easily reproducible results as can be obtained by any other formulas tried, with a considerable saving of time on account of the comparatively short fermentation period. For the purposes of this work, moreover, this baking procedure may be of decided advantage in that it tends to eliminate the factor of possible variation in diastatic values.

Discussion

Table I discloses a positive correlation between loaf volume and viscosity, all viscosities having been determined at one flour concentration, without previous removal of electrolytes. The correlation is not high. Preliminary removal of electrolytes resulted in a lowering of the correlation between actual viscosity and loaf volume. There was a positive correlation between total wheat protein and loaf volume. This correlation is the same, within limits of error, as that between viscosity and loaf volume, without preliminary removal of electrolytes, and agrees closely with similar correlations found by Mangels and Sanderson (1925) with North Dakota wheats. From results of these three sets of correlations, each of which involves more than 100 flours, milled and baked under identical procedures, two conclusions may be drawn. The first is that in the case of a Nebraska hard winter wheat flour a knowledge of its protein content alone furnishes as good a basis for estimating its baking strength as may be furnished by actual viscosity values. The second conclusion is that the value of such viscosity data was slightly lowered, rather than improved, by pre-

³ This was estimated by digesting a flour and water suspension at 27 degrees, according to the procedure of Rumsey (1922). The increase in reducing sugars during digestion was calculated as maltose, and was estimated by the picric acid method as modified by Willaman and Davison (1924), using a Buerker colorimeter, and matching the color against maltose solutions of known strength. This procedure requires no clarification of the extract, saves time, and appears to be reasonably accurate.

liminary removal of electrolytes. This would indicate that preliminary removal of electrolytes is unnecessary where flours of similar ash contents are to be compared with each other.

Table I further shows that when viscosities were reduced to a common protein basis, by dividing each viscosity value by the protein content of the sample involved, the correlation between the figures thus obtained and figures for loaf volume was nothing in one case, and very slight in the other. In other words, there was but little positive correlation between viscosity and loaf volume, where the quantity factor was eliminated from one and not from the other. These viscosity data appear to reflect quantity rather than quality of gluten. This is confirmed by the fairly high positive correlation between flour protein and actual viscosity, after the removal of electrolytes.

Table II presents results obtained when the exact procedure prescribed by Gortner (1924) was carefully followed with 19 selected flour samples, all experimentally milled and baked according to the same methods. All but one (599) are from Nebraska wheats of the 1923 crop. Since comparisons are based on loaf volumes, and quantity of protein is supposed to be a factor in producing loaf volume, the series has been arranged into several groups, each group consisting of flours of very nearly the same protein content. By comparing samples within their respective groups, therefore, the quantity factor is entirely eliminated. In group 1, flour 541 has the smallest loaf volume, although the highest constant "b." However, its diastatic value is practically the same as that of flour 580, which is the strongest flour in the group. Flour 403 has a very low quality constant, yet it gave a slightly better loaf than 541, which had the highest quality constant. This may have been due to its noticeably higher diastatic value. It is interesting to note that the strongest flour in the group, with an intermediate quality constant, ran lowest in quantity of glutenin, and had a low diastatic value. In group 2, flour 533, showing best baking strength, had the highest constant "b" and the lowest diastatic value. However, flour 523, showing poorest strength of the four, had the second highest quality constant, and was next to high in diastatic power. In the case of group 3, consisting of 4 flours, the two higher loaf volumes are associated with the two lower quality constants. The diastatic values and glutenin contents are all practically the same. In group 4 the quality constant for flour 402, which runs highest in loaf volume, is identical with that of flour 425, having the poorest loaf volume, notwithstanding the fact that the flour showing poorest strength had the highest diastatic value. In group 5, the stronger flour (No. 554) has decidedly the higher constant "b." In group 6,

however, the opposite is true, and the strong flour has a lower constant than the weaker one, both having comparatively low diastatic values. It is surprising to observe that of all 19 flours, the one having by far the highest constant "b" was sample 599, milled from Polish wheat, which had almost no baking strength whatever, as compared with the others. Little significance is attached to this, since Polish is an unusual variety of wheat, having little commercial importance. Excluding Polish flour, however, sample 541 has the lowest loaf volume but the highest quality constant of all samples. It may be observed that, with but one or two slight exceptions, the ratio of total protein to glutenin content is practically constant throughout the series, substantiating Gortner's (1924) previously quoted statement bearing on this point. Fluctuations in constant "K" indicate a lack of correlation between constant "b" and gluten quality as measured in terms of loaf volume per unit of glutenin, in many instances.

It is apparent from the data presented in Table II, and discussed in the preceding paragraph, that the quality constant "b" as determined according to the viscosimetric procedure of Gortner (1924) offered no satisfactory explanation for variations in baking strength found in a miscellaneous group of Nebraska wheat flours. There is, furthermore, no evidence that any viscosimetric procedure involved in these experiments may be expected to serve as a satisfactory basis for predicting the baking strengths of Nebraska wheat flours or for explaining occasional lack of strength. Obviously these results may be subject to various interpretations. It may be that this viscosity procedure gives a measure of gluten quality in the case of flours of certain sources or varieties, but is not a satisfactory measure for others, including those of Nebraska. Another possible conclusion is that some factor or factors *other* than gluten quality were responsible for the variations in baking strengths of the flours chosen for this study. If this is so, then diastatic activity and quantity of glutenin, as well as gluten quality, may be ruled out, since Table II shows that these factors bore no more relation to loaf volume than did the constant "b."

This paper is presented merely as a report of certain experiences with viscosity tests on a certain group of flours, and not as a critical study of the method or of the principles involved. The writers believe that such a critical study is at present precluded by lack of certain knowledge with regard to the numerous errors to which the method is subject, owing to the many factors which are known to affect viscosity measurements. Ostwald (1913) has enumerated 10 factors which may affect viscosity of emulsoids, while Sharp and Gortner (1923) have mentioned another one. Perhaps the most valid criticism

which, in the light of recent knowledge, can be applied to viscosity measurements with acidified flour and water suspensions is that such suspensions are generally subject to the laws of *plastic* rather than viscous flow. Recent work by Bingham (1922) has called attention to distinctions which must be made between plastic and viscous materials. In a recent paper, Bingham (1925) says "One must not expect useful information from determinations of 'apparent viscosity' if the material dealt with is really plastic in character." There is therefore reason for believing that although gluten quality may depend primarily upon its colloidal properties, a satisfactory method for quantitatively measuring these colloidal differences remains to be perfected. It furthermore appears probable that where viscosity measurements have proven to be useful indices of baking strength, this has been due to one of two causes. Either the wheats involved were more uniform with respect to variety or source, or both, than those dealt with in this report, with the result that the errors involved were more nearly constant, or certain chemists have been more successful than others in their ability to modify the procedure for practical and useful purposes.

Summary and Conclusions

More than 100 samples of Nebraska wheats collected during the season of 1922 were experimentally milled and baked. The actual viscosities of their respective acidified water suspensions (all at identical conditions of flour concentration and acidity), both with and without preliminary removal of electrolytes, were determined, using the MacMichael viscosimeter. Their respective protein contents were determined. Loaf volume was used to represent baking strength. Using the statistical method, coefficients of correlation were computed for loaf volume and each of the following factors, respectively: actual viscosity without removal of electrolytes, actual viscosity with preliminary removal of electrolytes, ratio of viscosity to protein content, both with and without previous removal of electrolytes, and total flour protein. The correlation between viscosity and protein content was also computed.

There was a decided positive correlation between loaf volume and protein content, although it was rather low. A positive correlation of the same order between actual viscosity (without preliminary removal of electrolytes) and loaf volume was found. There was a slight positive, but lower correlation between loaf volume and actual viscosity after removal of electrolytes. There was little or no positive correlation between loaf volume and ratio of actual viscosity to protein

content. There was a rather high positive correlation between actual viscosity and protein content. Therefore, for this series of flours, protein content would have been as valuable a basis for predicting baking strength as would have been a knowledge of actual viscosity. The factor of protein quantity apparently had more effect on actual viscosity than did protein quality, insofar as loaf volume is a fair criterion of protein quality in these experiments.

Constant "b" suggested by Gortner (1924) as a measure of gluten quality was determined for each of 19 flours. Diastatic value and amount of glutenin were also determined for each of these flours. Even among flours of similar protein content, no useful relationship between constant "b" and loaf volume was found. This could not be explained on the basis of either glutenin content or diastatic value. The ratio of total protein to glutenin content was apparently remarkably constant.

From data resulting from these experiments, either of the following conclusions is possible.

1. No generally known viscosimetric procedure has yet been perfected by means of which gluten strengths of Nebraska wheat flours may be predicted with reasonable accuracy.
2. There is some important factor aside from gluten quality—as measured by viscosimetric procedure—glutenin content, or diastatic value which determines baking strength in Nebraska wheat flours.

It is felt by the writers that the influence of many factors, both known and unknown, on viscosity determinations with acidified flour-in-water suspensions must be thoroughly understood, before the procedure may be modified in such a way that it will serve as a rapid, useful, and universal means of estimating flour strength.

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THE GLUTEN QUALITY OF FLOUR AND ITS ISO-ELECTRIC POINT

By E. L. TAGUE

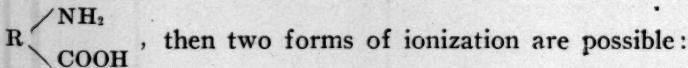
Agricultural Experiment Station, Manhattan, Kan.

(Read at the convention June 4, 1925)

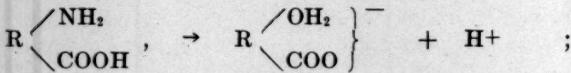
Gluten quality is the sum total of a large number of different factors. These factors are the physical and chemical properties of the given flour. In general this expression refers to all those desirable qualities of a flour which go to make up the best loaf of bread. As ordinarily used it has a somewhat vague and indefinite meaning. Even cereal chemists themselves are not agreed with regard to all the physical and chemical properties which should be included in this expression, or the relative importance of each. This state of affairs is due largely to the fact that at present there is no fundamental basis or reckoning point for gluten quality.

The iso-electric point is that hydrogen-ion concentration at which an amphoteric substance in solution gives an equal number of hydrogen and hydroxyl ions. In its true sense it refers only to a pure substance and not to a mixture. Thus it is the true neutral point for that substance. It is different for each amphoteric substance, and thus becomes a characteristic property of that substance.

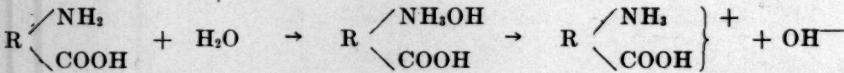
Other properties of the substance, as solubility, precipitability, viscosity, are at a maximum or minimum at the iso-electric point, depending on the property considered. The maximum basic power manifests itself on the acid side of the iso-electric point and the maximum acid power on the basic side. For instance, if the protein molecule is represented by



(1) ionization as an acid, thus:



(2) as a base upon hydrolysis, thus:



When this substance is brought into a solvent, i.e., a buffer solution, whose H-ion concentration is greater than its own iso-electric point, it will ionize predominately as a base. If the H-ion concentration of the buffer is less than its iso-electric point, it will ionize predominately as an acid.

Strictly speaking, the point at which the acid and the basic qualities of a mixture, such as flour, are equal is the point of minimum transference; that is, the point at which the ions given off by the soluble constituents of the flour collectively will transport the minimum amount of electric current when placed in an electric field. This point in a mixture corresponds to the iso-electric point of a pure amphoteric substance.

Throughout all colloid chemistry the true neutral point has been found to be of fundamental importance. Proteins are colloids. They are able to ionize both as an acid and as a base. The true neutral point of the proteins of flour, or of mixtures in which they are found (i.e., dough) is of fundamental importance in the consideration of gluten quality, as those qualities (i.e., viscosity), which are of utmost importance in baking strength, are at a maximum or minimum at this point. Hence the point of minimum transference of a flour is the logical basis or reckoning point for gluten quality.

With this idea in view the point of minimum transference for the following cereal products was determined: (1) a patent flour, (2) a clear flour, (3) a low-grade flour, (4) a whole-wheat flour, (5) a bran, all made from the same sample of Kansas hard wheat. These samples were obtained from the Milling Industry Department of the Kansas State Agricultural College.

Experimental

Method.—The method used in this investigation was an adaptation of the one employed by the author in determining the iso-electric points of gliadin and glutenin respectively.¹

As the constituents of the flour behave as bases on the acid side of the point of minimum transference and as acids on the basic side, it was desired to keep the acid radical of the buffer constant on the acid side and the basic radical of the buffer constant on the basic side. To this end 0.01 M KH_2PO_4 with varying amounts of dilute KOH were used as buffers on the acid side and 0.01 M K_2HPO_4 with varying amounts of dilute H_3PO_4 on the basic side.

Procedure.—Two series of buffer solutions with decreasing H-ion concentration were made up as follows: Series A.—20 cc. of 0.1 M KH_2PO_4 were pipetted into each of twelve 200-cc. flasks and increasing amounts of 0.01 N KOH were added as follows: Into the first, 0.0 cc.; into the second, 0.2 cc.; into the third, 0.5 cc.; into the

¹ Tague, E. L. 1925. The iso-electric points of gliadin and glutenin. Jour. Am. Chem. Soc., Vol. 47, p.418.

fourth, 1.0 cc., etc., throughout the series. The number of buffers required to bring the series to the point of minimum transference of the flour and the amount of KOH necessary to give the desired pH, had been determined by preliminary experiment. Series B.—20 cc. of 0.1 M K_2HPO_4 with varying amounts of dilute H_3PO_4 were placed in each of a series of fourteen 200-cc. flasks exactly as in series A. In this series the point of minimum transference was approached from the opposite side, that is, the first of the series was 0.01 M K_2HPO_4 . The amounts of 0.01 N H_3PO_4 added were as follows: To the first 0.0 cc.; to the second 5 cc.; to the third 10 cc.; to the fourth 15 cc., etc. In the tables, however, the results are arranged in the order of decreasing H-ion concentration.

The content of each flask was then made up to the mark with re-distilled CO_2 -free water. After shaking the flasks until the contents were thoroly mixed, the pH of each solution was determined electrometrically at 25° C. by means of the apparatus described in a previous article,² the saturated KCl calomel cell being used as the working cell. This was checked daily against the standard in the usual way.

One hundred cc. from each buffer solution thus prepared were pipetted each into a separate bottle of suitable capacity and 10 grams of the cereal product was added, together with 1 cc. of toluene as a preservative. The bottle was then corked tightly, placed on a shaking machine, and shaken constantly for two hours. The temperature was 25° C. At the end of this time the pH of the suspension was determined in the same way as that of the buffer.

In this way results were obtained which showed the effect of 10 grams of the given flour on a 100-cc. portion of each of a series of buffers whose H-ion concentration varied between that of 0.01 M KH_2PO_4 and that of 0.01 M K_2HPO_4 . (See tables.) At the same time the results showed the point of minimum transference, i.e., the point where the flour did not change the original pH of the buffer. The difference between the pH of the buffer and that of the resulting suspension is a direct measure of the effect of the flour on the pH of the buffer.

The results (the average of duplicate determinations) for each flour and for the bran are set forth in Tables I, II, III, IV, and V, respectively, and graphically in the chart, in which the difference between the pH of the buffer and that of the resulting suspension is plotted against the pH of the buffer. The + and — signs merely

² Tague, E. L. 1920. A study of the determination of the amino acids by means of the hydrogen electrode. Jour. Am. Chem. Soc., Vol. 42, p. 173.

indicate that the flour increases or decreases the H-ion concentration of the buffer respectively.

In addition the H-ion concentration of each flour and of the bran was determined, using a 10-gram charge and 100 cc. of distilled CO_2 -free water. All other conditions were the same as in the above. The results in pH were as follows: Whole wheat 6.373; patent 6.002; clear 6.103; low grade 6.221; bran 6.441.

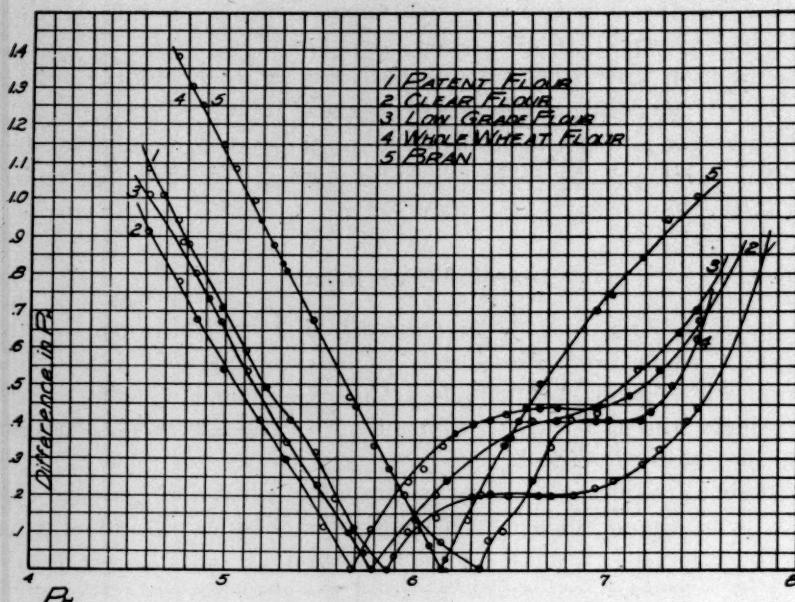
Discussion of Results

One of the first things to be noticed is that the constituents of the flour as a whole behave uniformly as bases on the acid side of the neutral point (point of minimum transference) and as acids on the basic side. This is in strict conformity with the behavior of amphoteric substances in general.

Another striking fact is that within certain limits on the acid side of the neutral point all the suspensions of each substance investigated give the same pH, respectively, notwithstanding that the pH of the buffer increases progressively. Thus all the suspensions of the patent flour in buffers from pH 4.615 to 4.987 give the same value, pH 5.697. Within the same range the clear flour gives a value of pH 5.528. This behavior shows in the chart as a straight line.

Within a short distance of the point of minimum transference, the pH of the suspensions of the four flours each gradually increases till the point of minimum transference is reached. This shows in the chart as a gradual flattening of the curve. In the case of bran, however, the pH of the suspension remains constant, even for a short distance beyond the neutral point. The flattening of the curve on the part of the flours is probably due to some small constituent of the flour (possibly the leucosin) having an iso-electric point in the neighborhood of pH 5.5. This would cause the gradual flattening of the curve from pH 5.5 to the neutral point beyond which on the alkaline side its influence would be covered up by the other constituents of the flour. As the bran does not contain appreciable amounts of leucosin, it does not show this behavior.

On the alkaline side of the neutral point a different set of phenomena are observed. In case of the four flours, the curves at first rise, then run horizontal for a short distance, then rise again. The



horizontal portion of the curve is undoubtedly caused by the gliadin and glutenin. The effect of the constituents of the flour on the buffer is slight here, owing to the fact that gliadin and glutenin unite to form gluten and thus undoubtedly neutralize each other. In the case of bran this horizontal portion is lacking.

Summary

A logical basis for the study and correlation of the different factors influencing gluten quality of flours is proposed. This is the point of minimum transference, or neutral point. This point in a mixture corresponds to the iso-electric point in a pure substance.

A method is given by which this point as well as the acidic and basic strength of a given flour can be accurately determined.

Curves are given which show the behavior of different grades of flour as well as the different constituents of the given flour within the zone (pH 4.5 to 7) important in gluten formation.

No relationship is apparent between the H-ion concentration of a flour and the point of minimum transference.

The relationship between the period of fermentation and the neutral point as well as other factors influencing gluten formation is being investigated in this laboratory.

TABLE I
RESULTS FOR PATENT FLOUR

No.	Phos. pH	Susp. pH	Diff. pH	No.	Phos. pH	Susp. pH	Diff. pH
1	4.615	5.697	-1.082	15	6.002	5.900	+0.102
2	4.683	5.697	-1.014	16	6.103	5.968	+0.135
3	4.750	5.697	-0.947	17	6.306	6.130	+0.203
4	4.818	5.697	-0.879	18	6.407	6.610	+0.203
5	4.987	5.697	-0.710	19	6.509	6.712	+0.203
6	5.106	5.697	-0.591	20	6.644	6.847	+0.203
7	5.224	5.714	-0.490	21	6.728	6.931	+0.203
8	5.342	5.748	-0.406	22	6.847	6.644	+0.203
9	5.478	5.799	-0.321	23	6.948	7.168	+0.220
10	5.596	5.782	-0.186	24	7.033	7.269	+0.236
11	5.697	5.816	-0.119	25	7.185	7.455	+0.270
12	5.799	5.833	-0.034	26	7.286	6.948	+0.338
13	5.866	5.866	0.000	27	7.422	7.016	+0.406
14	5.900	5.934	+0.034	28	7.489	7.050	+0.439

TABLE II
RESULTS FOR CLEAR FLOUR

No.	Phos. pH	Susp. pH	Diff. pH	No.	Phos. pH	Susp. pH	Diff. pH
1	4.615	5.528	-0.913	12	6.137	5.799	+0.338
2	4.750	5.528	-0.778	13	6.204	5.833	+0.371
3	4.852	5.528	-0.676	14	6.306	5.917	+0.389
4	4.987	5.528	-0.541	15	6.407	6.002	+0.405
5	5.190	5.596	-0.406	16	6.475	6.052	+0.423
6	5.325	5.630	-0.305	17	6.644	6.204	+0.440
7	5.528	5.647	-0.119	18	6.745	6.306	+0.439
8	5.664	5.664	0.000	19	6.948	6.509	+0.439
9	5.799	5.681	+0.118	20	7.117	6.644	+0.473
10	5.968	5.731	+0.237	21	7.286	6.745	+0.541
11	6.036	5.765	+0.271	22	7.489	6.813	+0.676

TABLE III
RESULTS FOR LOW GRADE FLOUR

No.	Phos. pH	Susp. pH	Diff. pH	No.	Phos. pH	Susp. pH	Diff. pH
1	4.615	5.664	-1.049	13	6.103	5.900	+0.203
2	4.784	5.664	-0.880	14	6.171	5.934	+0.237
3	4.852	5.664	-0.812	15	6.272	5.968	+0.304
4	4.920	5.664	-0.744	16	6.509	6.147	+0.362
5	4.987	5.664	-0.677	17	6.610	6.204	+0.406
6	5.122	5.664	-0.542	18	6.745	6.340	+0.405
7	5.325	5.664	-0.339	19	6.813	6.407	+0.406
8	5.495	5.731	-0.236	20	6.948	6.475	+0.473
9	5.664	5.765	-0.101	21	7.151	6.610	+0.541
10	5.731	5.781	-0.051	22	7.388	6.745	+0.643
11	5.799	5.799	-0.000	23	7.489	6.779	+0.710
12	5.968	5.866	+0.102				

TABLE IV
RESULTS FOR WHOLE WHEAT FLOUR

No.	Phos. pH	Susp. pH	Diff. pH	No.	Phos. pH	Susp. pH	Diff. pH
1	4.615	6.137	-1.522	14	6.340	6.340	0.000
2	4.835	6.137	-1.302	15	6.407	6.340	+0.067
3	5.055	6.137	-1.082	16	6.475	6.357	+0.118
4	5.190	6.137	-0.947	17	6.610	6.373	+0.237
5	5.258	6.137	-0.879	18	6.712	6.380	+0.332
6	5.325	6.137	-0.812	19	6.813	6.407	+0.406
7	5.461	6.137	-0.676	20	6.948	6.543	+0.405
8	5.562	6.137	-0.575	21	7.016	6.610	+0.406
9	5.664	6.171	-0.473	22	7.185	6.779	+0.406
10	5.866	6.171	-0.271	23	7.219	6.796	+0.423
11	6.002	6.171	-0.135	24	7.354	6.847	+0.507
12	6.069	6.171	-0.102	25	7.489	6.864	+0.625
13	6.137	6.204	-0.067				

TABLE V
RESULTS FOR BRAN

No.	Phos. pH	Susp. pH	Diff. pH	No.	Phos. pH	Susp. pH	Diff. pH
1	4.615	6.137	-1.522	13	6.171	6.137	+0.034
2	4.750	6.137	-1.387	14	6.272	6.137	+0.135
3	4.886	6.137	-1.251	15	6.340	6.137	+0.203
4	4.987	6.137	-1.150	16	6.475	6.137	+0.338
5	5.156	6.137	-0.981	17	6.543	6.137	+0.406
6	5.308	6.137	-0.829	18	6.578	6.137	+0.439
7	5.461	6.137	-0.676	19	6.644	6.137	+0.507
8	5.697	6.137	-0.440	20	6.948	6.238	+0.710
9	5.799	6.137	-0.338	21	7.016	6.272	+0.744
10	5.934	6.137	-0.203	22	7.185	6.340	+0.845
11	6.002	6.137	-0.135	23	7.320	6.373	+0.947
12	6.069	6.137	-0.068	24	7.489	6.475	+1.014

HYDROGEN IONS AND THEIR APPLICATION TO MILL CONTROL

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(Read at the convention June 4, 1925)

The title of this paper is perhaps misleading. One reading the title might expect that we were going to give some system of controlling a mill by making a determination of the concentration of hydrogen ions either on wheat or mill products. Such is not the case.

Three years ago Weaver and Goldtrap presented a paper before this association in which the relation of the fermentation period of a flour to its hydrogen-ion concentration and its buffer action was indicated. Our work at that time convinced us of the desirability of maintaining a uniform hydrogen-ion concentration in the various grades of flour. With this thought in mind, we have made observations and recorded results covering a period of more than three years, trying to find some way in which to control the concentration of hydrogen ions in mill products.

The wheat used in the milling mixture, the effect of the temper on wheat, the humidity and temperature at which the milling process took place have all been studied. The effects of the various bleaching agents have also been studied.

In looking over the data covering the three-year period, we find the highest concentration of hydrogen ions encountered in any wheat tested in that time, expressed as pH, was 6.21. The lowest was pH = 6.84. The highest concentration was found in a sample of Colorado wheat of the turkey variety; the lowest in a sample of Canadian spring. The range in wheat covering the three-year period received at the mill for grinding was from pH = 6.433 to pH = 6.77.

The wheat lowest in pH was from the latter part of the crop harvested in 1921. Practically all the wheat received at that time was running the same.

The highest pH recorded was on the present crop, a crop which up to date, has averaged pH = 6.634, with a range from pH = 6.57 to 6.77.

As long as a wheat is drawn from one certain territory, changes in protein apparently have no effect on the hydrogen-ion concentration. Table I gives the range of protein and the pH values found for wheat binned and classified as to protein in April, 1923.

TABLE I

HYDROGEN-ION CONCENTRATION (AS pH) OF WHEATS CLASSIFIED ON THE BASIS
OF PROTEIN CONTENT

Protein range Per cent	pH
Below 11.....	6.58
11.50 to 12.00.....	6.63
12.00 to 12.50.....	6.64
12.50 to 13.00.....	6.63
13.00 to 14.00.....	6.65

This work has been repeated several times, and while the values obtained were not always the same, we have always found the range between the various proteins to be as close as that listed above. We have found the pH in wheat to vary from crop to crop, and on some crops to increase with the age of the wheat.

We find nothing to control by blending wheats, when all the wheat used is grown in one territory. Such variations as occur are seasonal and from crop to crop, and do not lend themselves to control. A mill using a large variety of wheat from all sections of the country would probably find enough variations even on the same crops and during different seasons to make the hydrogen-ion concentration determination one of equal value with protein and moisture in binning wheat for the mill mixture.

During the three years we have been making these observations we have used a tempering period of from 18 to 36 hours. We have found no definite relation between the length of the temper and the concentration of hydrogen ions in the wheat. Sometimes the tempered wheat is slightly higher in pH value than the untempered, sometimes slightly lower. In general the tempered wheat has the higher pH value, that is, its concentration of hydrogen ions is less. During this period of observation we have started wheat to the temper at a temperature of from 70° F. to 90° F., and have brought wheat to the rolls at a temperature of from 85° F. to 100° F. with no significant change in pH.

It is our opinion that to effect a great change in the pH of wheat the tempering period would have to be carried on to such lengths that unsoundness and mustiness might result.

Our study of the effect of humidity and temperature is not of three years' duration and our data on this are far from complete.

One grade of flour studied shows a variation of from pH = 6.00 to pH = 6.15 over a range of relative humidity from 32 to 46, increasing hydrogen-ion concentration being shown as the relative humidity increased.

With temperature ranges of from 76° F. to 91° F. we find changes in pH from 6.05 to 6.15, the highest pH recorded being produced at 80° F., the lowest at 91°.

These are very slight changes, and could easily be effected by slight changes in the percentage of the grade or a slight change in ash. We have studied this phase of the subject only a short time, and are not prepared to say whether or not a regulation of heat and humidity will effect a control of the hydrogen ions in the flour. We have not made enough determinations, neither have we covered a large enough range of temperatures or humidities to come to any conclusions.

Our observations on the use of the various bleaching agents show that Novadel and Agene have no effect on the hydrogen-ion concentration of the flours treated. The Alsop process effects a slight increase in the hydrogen-ion concentration and the application of chlorine effects a greater one. Table II shows the effects of some of the various bleaching agents on freshly milled flours.

TABLE II
CHANGES IN HYDROGEN-ION CONCENTRATION (AS pH) OF FLOUR EFFECTED BY TREATMENT WITH THE ALSOP PROCESS AND CHLORINE

Grade of flour	Bleaching agent	Bleached	Unbleached
		pH	pH
Patent hard wheat	Alsop	5.94	6.08
Patent soft wheat	Alsop	5.70	5.74
Clear hard wheat	Chlorine	6.47	6.53
Patent hard wheat	Alsop	6.03	6.23
Clear hard wheat	Alsop and chlorine	6.37	6.47
Straight hard wheat	Alsop	6.22	6.39
Clear hard wheat	Chlorine	6.39	6.50
Patent hard wheat	Chlorine	5.96	6.12
Straight hard wheat	Alsop	6.28	6.34
Clear hard wheat	Chlorine	6.27	6.41
Straight hard wheat	Chlorine	5.94	6.22
Straight hard wheat	Chlorine	5.45	6.02

Table II includes flours furnished us by various flour mills and the strength of treatment used is not known.

Table III includes flours treated by chlorine, $\frac{1}{2}$ ounce per barrel for patent, $\frac{3}{4}$ ounce for straight, 1 ounce for clear, and $1\frac{1}{2}$ ounces for second clears.

TABLE III
HYDROGEN-ION CONCENTRATION (AS pH) OF VARIOUS GRADES OF FLOUR TREATED BY CHLORINE

Grade of flour	Quantity of chlorine per barrel	Bleached	Unbleached
		oz.	pH
Hard winter patent	0.50	5.621	6.027
Hard winter straight	0.75	5.790	6.297
Hard winter clear	1.00	6.196	6.432
Hard winter 2d clear	1.50	6.263	6.483

Table IV includes flours treated with Agene using $1\frac{1}{2}$ grams per barrel for patent, 2 grams for straight, 3 grams for clear, and $3\frac{1}{2}$ grams for 2nd clear.

TABLE IV
HYDROGEN-ION CONCENTRATION (AS pH) OF VARIOUS GRADES OF FLOUR TREATED WITH AGENE

Grade of flour	Bleached	Unbleached
	pH	pH
Hard winter patent.....	6.060	6.010
Hard winter straight.....	6.077	6.077
Hard winter clear.....	6.365	6.517
Hard winter 2d clear.....	6.466	6.466

Table V shows some comparisons made on one grade of flour using Novadel as bleaching agent, $\frac{1}{2}$ ounce to the barrel.

TABLE V
HYDROGEN-ION CONCENTRATION OF FLOURS TREATED WITH NOVADEL

Bleached	Unbleached
pH	pH
6.110.....	6.132
6.000.....	6.060
6.093.....	6.011
6.029.....	6.014
6.125.....	6.014

The determinations recorded in Table V were selected from a great number of similar comparisons all showing the same results, that is, that treating flour with the Novadel treatment does not affect the concentration of hydrogen ions.

Summary

We find that when wheat is all drawn from one territory, the change in hydrogen-ion concentration occurs on different crops and during different seasons, and does not lend itself to mill control by blending or selection.

The tempering process affects the hydrogen-ion concentration of wheat but little, when carried to a period of 36 hours. Longer periods of tempering might be the cause of unsound and musty flour. The tempering process accordingly offers no means of controlling the hydrogen-ion concentration of mill products.

The effect on the concentration of hydrogen ions in mill products of the humidity and temperature at which the milling operation takes place has not been studied enough to draw any conclusions.

The application of the Alsop process of bleaching effects a slight increase in the hydrogen-ion concentration of flour.

The application of chlorine gas effects a substantial increase in the concentration of hydrogen ions.

The use of Agene or of Novadel is without effect on the hydrogen-ion concentration of flour.

EFFECTS OF DIASTASE AND MALT EXTRACT IN DOUGHS

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(Read at the convention June 2, 1925)

Introduction

A review of the literature,¹ on the baking qualities of wheaten flour will indicate the importance and the complicated nature of this subject. The problem of flour strength has been attacked in a number of ways and perhaps the procedures promising the greatest success are those dealing with the colloidal properties of the gluten and those dealing with yeast activity in the dough through the action of diastatic and proteolytic enzymes.

Wood (1907) was perhaps the first to call attention to the diastatic content of flour and its relation to the loaf volume of the resulting bread. He believes that the sugar content of the dough, particularly in the later stages of fermentation, determine the size of the loaf.

Baker and Hulton (1908) found that the diastatic activity of flours increased roughly as the baking strength of the flour increased.

Ford and Guthrie (1908) could not correlate baking strength with diastatic activity of the flour. They demonstrated, however, the presence of proteolytic enzymes in flour by the liquefaction of 1% gelatin, and believe that the proteases are probably a more valuable consideration. They conducted baking tests with added proteases in the dough. Naturally the dough did not rise during the fermentation period, the resulting bread being a soggy mass. They concluded that proteases decrease the gas-holding properties of the gluten, and point out that this is the chief reason for failure in the use of diastatic malt extracts in baking practice.

Bailey and Weigley (1922) found that flour strength depended upon factors which control the rate of carbon dioxide production and the amount of carbon dioxide lost during fermentation.

Rumsey (1922) states "the flour showing the greater diastatic power should show the greater strength and consequently the greater baking value, providing the relative quality and quantity of the gluten is the same."

Collatz (1922) shows an increase in volume of bread by a limited addition of diastatic malt flour and malt extract to the dough but with a decrease in color of the bread crumb.

¹ P. F. Sharp and R. A. Gortner. Viscosity as a measure of hydration capacity of wheat flour and its relation to baking strength. Tech. Bul. 19. Minn. Agr. Exp. Sta. 1923.

Sharp and Gortner (1924) show that the addition of diastatic malt flour and malt extract decreases the viscosity of the gluten in a dough as fermentation progresses. This decrease is proportional to the amount of diastatic preparation added and is undoubtedly due to the proteolytic enzymes present in the malt.

Experimental

The use of malt extracts in baking practice is quite universal and its chief function in the dough is its use as a fermentable carbohydrate and as a yeast food. In past years practically all malt extracts contained diastase, varying a good deal in diastatic activity. Today the non-diastatic malt extract is crowding the diastatic preparations off the market. The reason for this I will attempt to demonstrate in this paper.

As pointed out by Ford and Guthrie (1908) and others, diastatic malt extracts contain appreciable amounts of proteolytic enzymes, which decrease the gas-holding and imbibitional capacity of the gluten. In practice, therefore, only a small amount of diastatic extract could be used in a dough. The action of diastase and protease in a dough is very fast and can be detected by the expert baker immediately after mixing. According to the amount of diastatic preparation added, the dough will feel soft, soft and wet, or soft and sticky. The problem then presented is how much diastase should be added to a dough (if any) in order to secure the maximum baking value of the flour with which the baker is working without decreasing the color and texture of the resulting bread.

Methods and Materials

Experience has shown that from 3 to 4 per cent fermentable carbohydrate is necessary for a vigorous fermentation and still to bake out bread with the required amount of sweetness and flavor. Accordingly in all our baking tests we have used 4 per cent extract. In order to vary the diastase added to the dough, we prepared a series of extracts with increasing amounts of diastatic activity, keeping the maltose, color, and protein content as constant as possible. This was done by adding increasing amounts of high diastatic extract to a non-diastatic extract. The diastatic power of the extracts so prepared is given in Table I.

TABLE I
DIASTATIC POWER OF EXTRACTS

Sample No.....	1	2	3	4	5	6	7	8	9	10	11
Degrees Lintner.....	None	10.2	15.1	19.9	23.6	28.3	33.0	38.9	50.1	68.2	82.2

Three commercial patent flours were secured for the tests and the analyses are given in Table II. Analysis of protein, ash, and moisture was made according to A. O. A. C. methods; while gluten quality was determined with a MacMichael viscosimeter according to the method of Sharp and Gortner (1924). Diastatic activity (Lintner value) was determined by extracting 25 grams of flour with 500 cc. of water, digesting 3 hours at 25° C. filtering, and determining the Lintner value in the conventional way.

TABLE II
ANALYSES OF FLOURS I, II, AND III

	I	Flour II	III
Protein, per cent ($N \times 5.7$).....	11.02	10.88	12.09
Ash, per cent.....	0.39	0.42	0.42
Moisture, per cent.....	13.48	13.37	12.97
Absorption, per cent.....	52.00	52.00	52.00
Diastase (degrees Lintner).....	14.80	17.60	18.20
Quality factor.....	2.85	2.77	2.62
pH	5.944	5.826	5.868

The pH of the flour was determined with a Bailey hydrogen electrode and a Leeds & Northrup type K potentiometer on a centrifuged extract of 20 grams of flour digested 1 hour at 25° C. with 200 cc. of water.

Reducing Sugars in Flours and Doughs as Formed by Extracts

The diastatic activity of the extracts prepared above is shown by their action on the three flours and is presented in Table III and graphically in Figure 1. The method is the same as used by Collatz (1922) and consists of digesting 10 grams of flour with 100 cc. of a 0.4% solution of the extract at 27° C. for 1 hour. After the digestion period the flour suspension is transferred quantitatively to a 200-cc. volumetric flask, clarified with Na_2WO_4 , and centrifuged. The reducing sugars were determined by the Munson and Walker method on 50-cc. aliquots.

Essentially the same technique is employed in determining the reducing sugars in the dough. Twenty grams of dough are pinched off immediately after mixing, 1 hour after mixing, after the dough period, and after the proofing period. The dough is macerated in a mortar with H_2O until a smooth suspension is secured. This is transferred to a 200-cc. volumetric flask and clarified in the same manner as the flour suspensions. After centrifuging, it was necessary to filter; and 50-cc. aliquots of the filtrate were run for reducing sugars by the Munson and Walker method.

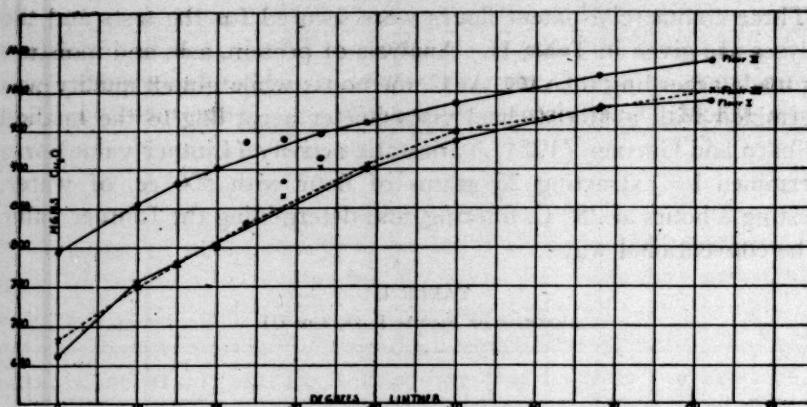


Fig. 1. Reducing Sugars Formed when Flours I, II, and III Are Digested 1 Hour at 27° C. with 4% Extracts 1 to 11

Baking Tests

The baking tests were carried out according to the following formula:

Flour	300 grams	Yeast	3 grams
Water	156 "	Salt	5 "
Extract	12 "	Lard	10 "

The flour and all ingredients were brought to a temperature of 30° C. in a proofing cabinet and then mixed exactly 3 minutes. The temperature of the water added was so regulated that the temperature of the dough was exactly 30° C. after mixing. The dough was then allowed to ferment until it had reached a volume of 1350 cc. It was then rounded up and allowed to rest 12 minutes, after which it was molded and panned. The dough was then proofed at 45° C. until it had reached a specified height and was then baked exactly 30 minutes at 210° C. The bread was examined after 24 hours for volume, expansion, color, and texture.

TABLE III

REDUCING SUGARS PRODUCED FROM 10 GRAMS OF FLOURS I, II, AND III WHEN DIGESTED 1 HOUR AT 27° C. WITH 0.4 GRAMS OF EXTRACTS 1 TO 11

Flour Extract No.	Mgms. Cu ₂ O		
	I	II	III
Flour blank.....	244.8	372.8	288.0
1.....	662.4	794.8	682.4
2.....	756.4	856.4	748.4
3.....	780.8	883.2	779.2
4.....	802.8	902.0	800.4
5.....	830.8	936.0	828.0
6.....	885.2	939.0	866.0
7.....	916.0	946.4	904.0
8.....	902.0	960.8	907.2
9.....	937.6	985.6	949.2
10.....	979.6	1019.2	976.0
11.....	987.2	1038.0	1000.4

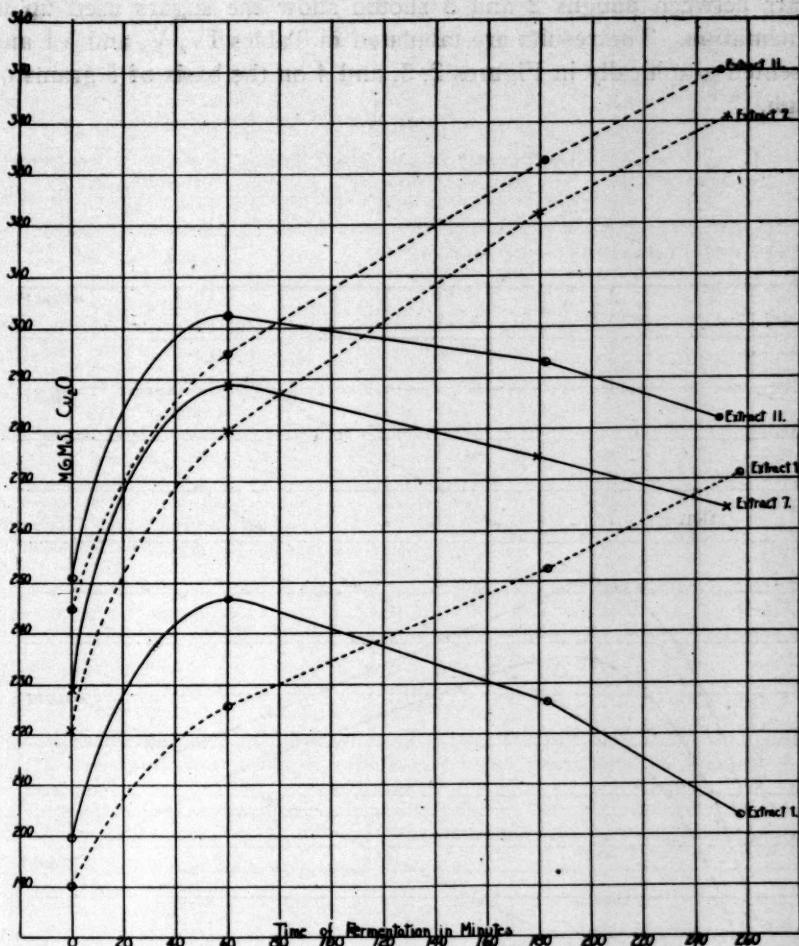


Fig. 2. Production of Reducing Sugars in the Fermentation of Flour I with Extracts 1, 7, and 11 (full lines indicate yeast doughs, dotted lines no yeast dough)

The reducing sugars formed in the doughs were determined on the three flours using 4% of extracts 1, 7, and 11 as the source of fermentable sugars and diastase. (Extract 1 is non-diastatic while extracts 7 and 11 show 33.0° and 82.2° Lintner, respectively.) Three doughs were mixed. The first, serving as control, was handled in the usual way thereby giving us the exact time when samples of the other two doughs were to be taken. Dough No. 2 was mixed the same as the control dough, and 20-gram samples were taken from this for analysis. Dough No. 3 was mixed without yeast and samples were taken from it the same as from No. 2. The differences in reducing

sugars between doughs 2 and 3 should show the sugars used up in fermentation. The results are tabulated in Tables IV, V, and VI and presented graphically in Figures 2, 3, and 4 on the basis of 5 grams of dough.

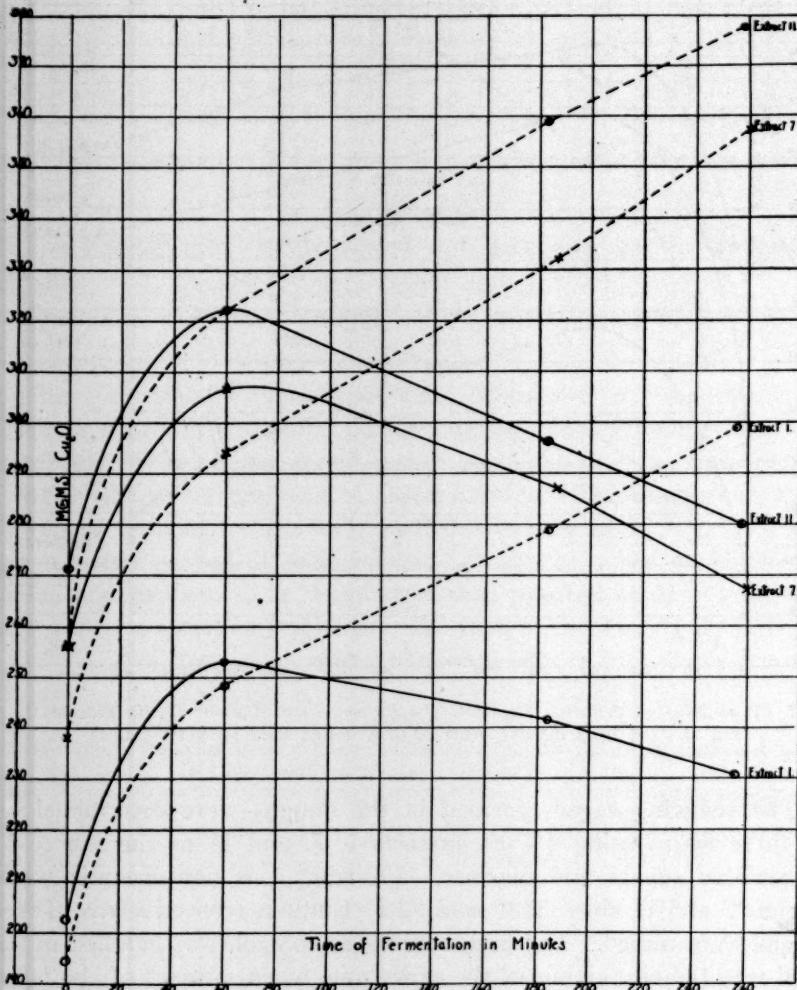


Fig. 3. Production of Reducing Sugars in the Fermentation of Flour II with Extracts 1, 7, and 11 (full lines indicate yeast doughs, dotted lines no yeast dough)

TABLE IV

PRODUCTION OF REDUCING SUGARS (EXPRESSED AS MGMS. Cu₂O ON 5 GRAMS OF DOUGH) IN FERMENTATION OF FLOUR I WITH AND WITHOUT YEAST, WITH 4% EXTRACTS 1, 7, AND 11 ADDED

	Time, minutes	Yeast dough Mgms. Cu ₂ O	No yeast dough Mgms. Cu ₂ O
Extract 1 (non-diastatic)			
After mix.....	0	199.5	189.9
One hour later.....	60	246.7	225.7
After dough time.....	183	226.3	252.6
After proof (to oven).....	257	203.6	271.3
Extract 7 (33.0° Lintner)			
After mix.....	0	229.0	221.0
One hour later.....	60	288.8	279.8
After dough time.....	179	274.6	322.0
After proof (to oven).....	252	264.4	341.2
Extract 11 (82.2° Lintner)			
After mix.....	0	251.2	245.0
One hour later.....	60	302.4	295.0
After dough time.....	182	293.2	332.3
After proof (to oven).....	249	282.0	350.2

TABLE V

PRODUCTION OF REDUCING SUGARS (EXPRESSED AS MGMS. Cu₂O ON 5 GRAMS OF DOUGH) IN FERMENTATION OF FLOUR II WITH AND WITHOUT YEAST, WITH 4% EXTRACTS 1, 7, AND 11 ADDED

	Time, minutes	Yeast dough Mgms. Cu ₂ O	No yeast dough Mgms. Cu ₂ O
Extract 1 (non-diastatic)			
After mix.....	0	202.5	194.2
One hour later.....	60	252.8	248.5
After dough time.....	184	241.5	278.6
After proof (to oven).....	256	230.8	299.0
Extract 7 (33.0° Lintner)			
After mix.....	0	256.2	238.0
One hour later.....	60	306.5	293.9
After dough time.....	187	287.0	332.0
After proof (to oven).....	260	267.2	357.3
Extract 11 (82.2° Lintner)			
After mix.....	0	271.2	256.3
One hour later.....	60	322.2	322.8
After dough time.....	183	296.2	359.0
After proof (to oven).....	258	279.9	377.8

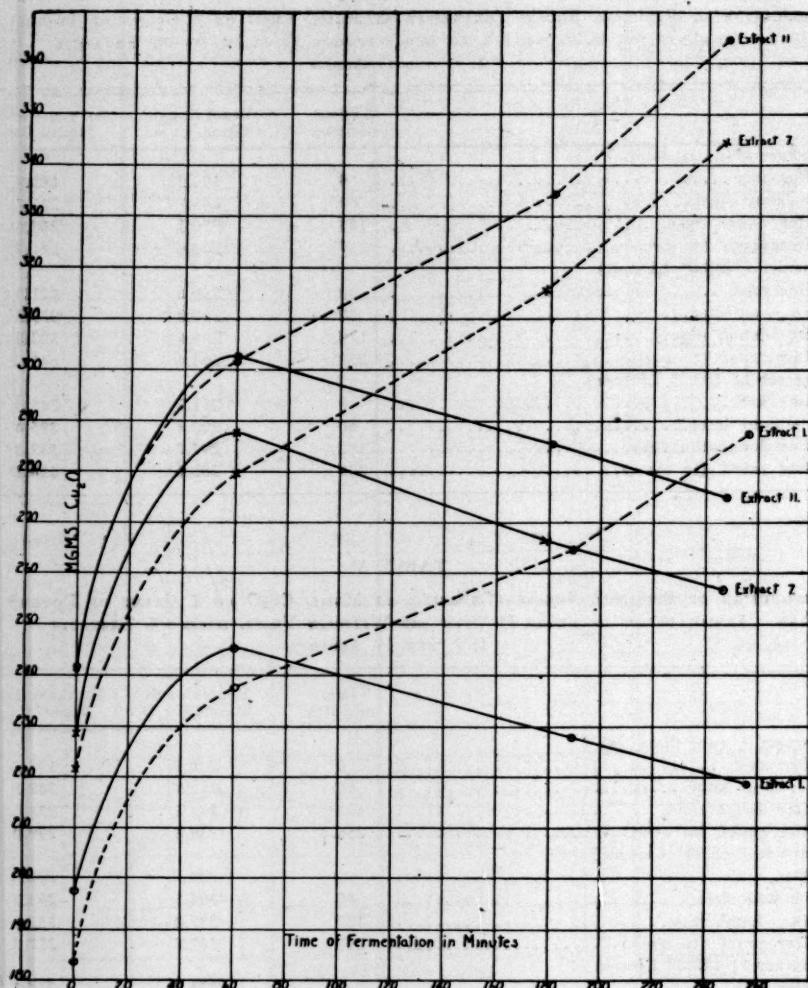


Fig. 4. Production of Reducing Sugars in Fermentation of Flour III with Extracts 1, 7, and 11 (full lines indicate yeast doughs, dotted lines no yeast dough)

TABLE VI

PRODUCTION OF REDUCING SUGARS (EXPRESSED AS MGMS. Cu₂O ON 5 GRAMS OF DOUGH) IN FERMENTATION OF FLOUR III, WITH AND WITHOUT YEAST, WITH 4% EXTRACTS 1, 7, AND 11 ADDED

	Time, minutes	Yeast dough Mgms. Cu ₂ O	No yeast dough Mgms. Cu ₂ O
Extract 1 (non-diastatic)			
After mix.....	0	197.5	183.2
One hour later.....	60	245.5	237.6
After dough time.....	189	227.8	264.7
After proof (to oven).....	256	218.6	287.3
Extract 7 (33° Lintner)			
After mix.....	0	228.4	221.8
One hour later.....	60	287.6	279.2
After dough time.....	178	266.4	315.4
After proof (to oven).....	247	256.7	344.4
Extract 11 (82.2° Lintner)			
After mix.....	0	241.9	241.5
One hour later.....	60	302.4	301.5
After dough time.....	181	285.2	334.2
After proof.....	248	274.9	364.4

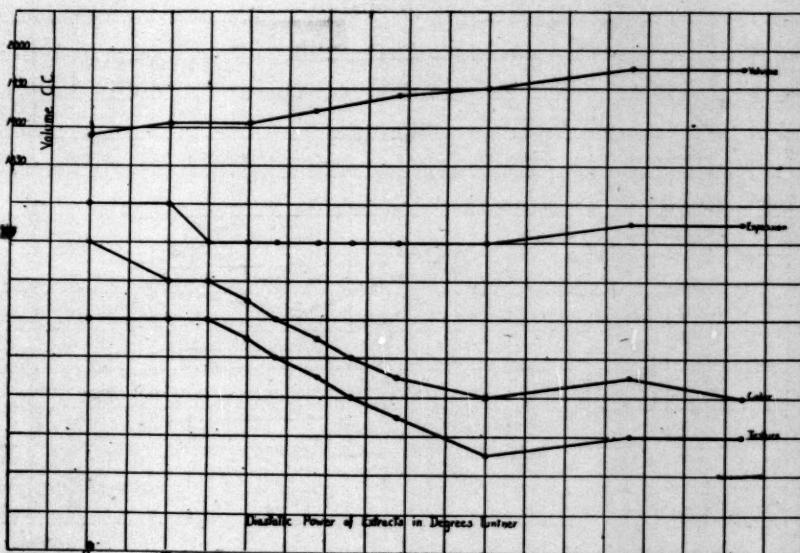


Fig. 5. Effects of Increasing Amounts of Added Diastase on Baking Qualities of Flour I

In the baking experiments conducted to test the comparative effects of added diastatic extracts upon the three flours, the series of eleven extracts, previously described, were used. These were added in amounts of 4%, on the basis of flour weight, and the results are recorded in Tables VII, VIII, and IX as time of fermentation, time of proofing, total time of fermentation, volume of loaf, expansion or lift of loaf, texture and color of crumb, and condition of dough from mixer. Loaf volume, expansion, texture, and color are recorded graphically in Figures 5, 6, and 7, and give at a glance the effects of the added diastase. Each dough came from the mixer at a temperature of 30° C. and was fermented at this temperature, the proofing period was at a temperature of 45° C. and each loaf was baked exactly 30 minutes at 210° C.

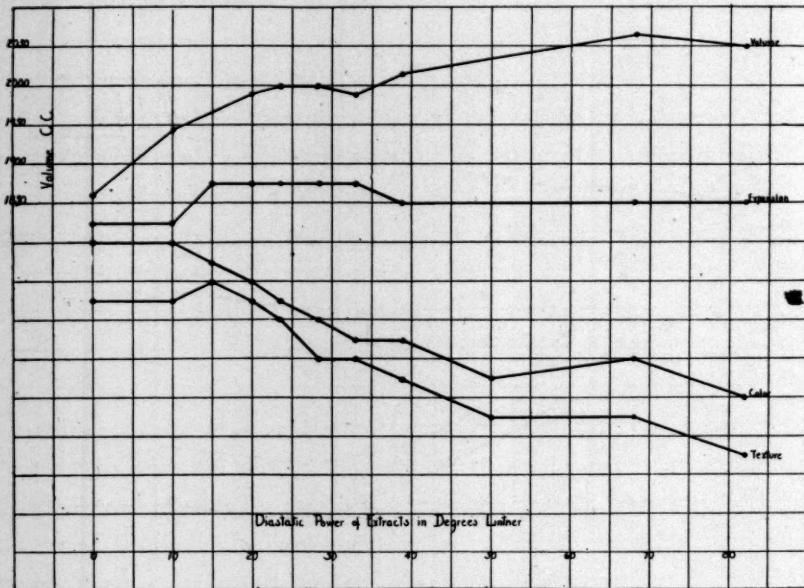


Fig. 6. Effects of Increasing Amounts of Added Diastase on Baking Qualities of Flour II

Discussion

Flours II and III show about the same diastatic power when determined by the Lintner method (Table II), with flour I appreciably lower. When autolized with and without added diastase (Table III, Figure 1) using the flour starch as substrate, flours I and III are almost alike in diastatic power and are appreciably lower than flour II. This would indicate that flour III did not have as high a liquifying power as flour II. These results are further illustrated in Tables IV, V, and VI and Figures 2, 3, and 4 when the reducing sugars were determined at various stages of fermentation, flour II showing the greatest production of reducing sugars, with flours I and III about even.

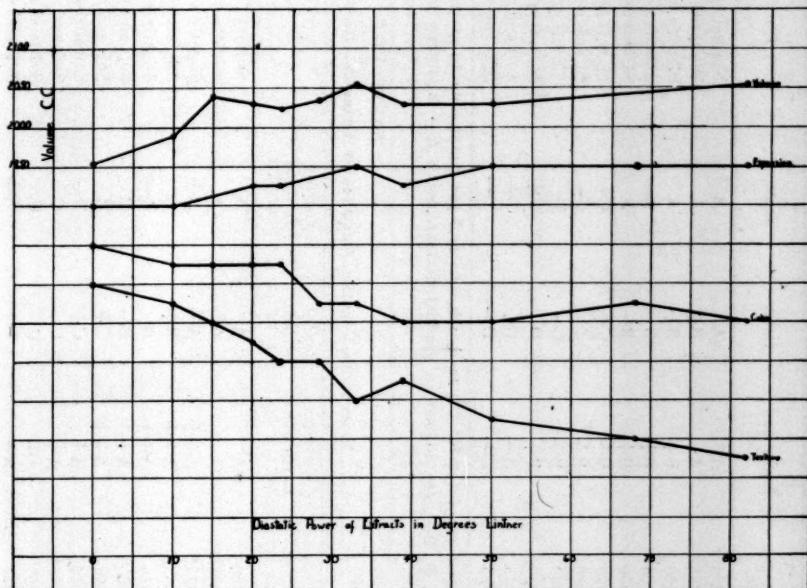


Fig. 7. Effects of Increasing Amounts of Added Diastase on Baking Qualities of Flour III

TABLE VII
EFFECTS OF VARYING AMOUNTS OF DIASTASE UPON BAKING QUALITIES OF FLOUR I

Extract No.	Volume cc.	Expansion	Color	Texture	Dough condition from mixer	Dough time Minutes	Pan proof time Minutes	Total time Minutes
1	1890	A†	A	A	Normal	184	60	256
2	1905	A	B+	A	Wetter than No. 1	185	61	258
3	1860	B+	B+	A	Slightly wet	186	60	258
4	1905	B+	B	A-	Sl. soft and sl. wet	187	60	259
5	1930	B+	B-	B	Sl. soft and wet	186	61	259
6	1920	B+	C+	C+	Sl. soft and wet, more so than No. 5	189	61	262
7	1980	B+	C	C-	Sl. soft and wet, more so than No. 6	186	62	260
8	1940	B+	C-	D	Sl. soft and wet, more so than No. 7	187	61	260
9	1950	B+	D	E+	Sl. soft and sticky	186	60	258
10	1975	A-	D+	D-	Soft and sticky	185	58	255
11	1975	A-	D-	D-	Soft and sticky	183	58	253

*Add 12 minutes bench proof (at 30° C.) to dough time and pan proof time to get total time of fermentation.

†Notations A, B+, B-, etc. indicate a gradual decrease, viz.: A— is slightly inferior in color than A, but is slightly better than B+.

TABLE VIII
EFFECTS OF VARYING AMOUNTS OF DIASTASE UPON BAKING QUALITIES OF FLOUR II

Extract No.	Volume cc.	Expansion	Color	Texture	Dough condition from mixer	Dough time Minutes	Pan proof time Minutes	Total time Minutes
1	1860	A	A	A	Normal	184	62	258
2	1945	A	A	A	Slightly wet	187	63	262
3	1875*	A++	A-	A+	Slightly soft	186	63	261
4	1985	A++	B+	A	Slightly soft and wet	187	64	263
5	2000	A++	B	A-	Slightly soft and wet	185	62	259
6	2000	A++	B-	B	Soft and wet	188	62	262
7	1990	A++	C+	B	Soft and wet, more so than No. 6	187	60	259
8	2015	A++	C+	B-	Softer than No. 7; slightly sticky	186	63	261
9	1970*	A++	C-	C	Soft and stickier than No. 8	180	61	253
10	2065	A++	D+	C	Soft and sticky	186	60	258
11	2050	A+	D+	D+	Soft and sticky	183	59	254

*Double break.

TABLE IX
EFFECTS OF VARYING AMOUNTS OF DIASTASE UPON THE BAKING QUALITIES OF FLOUR VII

Extract No.	Volume cc.	Expansion	Color	Texture	Dough condition from mixer	Dough time Minutes	Pan proof time Minutes	Total time Minutes
1	1955	A	A	A	Normal	172	58	242
2	1990	A	A-	A-	Slightly wet	175	60	247
3	2035	A+	B+	B+	Slightly soft	172	58	242
4	2030	A+	A-	R	Sl. soft and sl. wet, more so than No. 3	174	59	245
5	2025	A+	A-	B-	Sl. soft and sl. wet, more so than No. 4	173	58	243
6	2035	A+	B	B-	Sl. soft and sl. wet, more so than No. 5	177	57	246
7	2055	A++	B	C	Soft and wet	172	56	240
8	2030	A+	B-	C+	Soft and slightly sticky	177	57	246
9	2030	A++	B-	C-	Soft and sticky	172	56	240
10	2160	A++	B	D+	Soft and sticky	172	56	240
11	2055	A++	B	D	Soft and sticky, more so than No. 10	171	55	238

A good deal of conversion takes place at or immediately after mixing as shown by the data in Tables IV, V, VI, and Figures 2, 3, and 4. It will be noted that each flour is fermented with three extracts, No. 1 being non-diastatic, No. 7 having a Lintner value of 33°, and No. 11 a Lintner value of 82.2°. The reducing sugars in the doughs, when analyzed immediately after mixing, show a very decided increase, as extracts of increased diastatic power are added. The action of the diastatic malt extract on the flour probably accounts for the doughs becoming soft, soft and wet, or wet and sticky when diastatic malt extract is added to the dough.

All three flours produced enough fermentable sugars during the fermentation period (with extract No. 1 non-diastatic) to supply all the carbohydrate requirements of the yeast, so additional diastase is not essential for a strong, vigorous fermentation. Very little can be said about the effects of added diastatic malt extract on speed of fermentation, the time of fermentation being shortened in flours I and III with the addition of diastatic malt extract; while flour II developed fastest with no added diastatic malt extract.

The baking data need very little discussion, as Figures 5, 6, and 7 show the effects of added diastatic malt extract to the dough. There is a general increase in volume with all three flours with the addition of diastatic extracts. Flours II and III show an increase in expansion or oven lift while flour I shows a decrease. A very decided decrease in color of crumb and texture takes place as the amount of diastase is increased in the dough for all three flours, this decrease being less marked in flour III than in the other two. Of the three flours investigated, flour III showed the greatest baking strength, flour II was next, while flour I was apparently the weakest. The data submitted on these three flours seem to indicate that flours with higher diastatic activity, with equal protein content and gluten quality, do not necessarily show the greater baking strength. It is also evident that an increase in the proportion of diastatic malt extract added to a dough (the flour being of average baking quality) decreases the quality of the resulting bread, thereby decreasing its baking value.

Summary

The Lintner diastase value of a flour is not an accurate index of its converting powers in a dough.

Using the flour as substrate, an accurate idea of the reducing sugars which will be formed in a dough can be estimated.

When diastatic malt extract is added to a dough, a large amount of conversion takes place in mixing, this being evidenced by a soft, wet, or sticky dough.

The addition of diastatic malt extract to flours of average baking strength apparently decreases the quality of the resulting bread.

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SCIENCE IN EXPERIMENTAL BAKING

By C. B. KRESS

Sperry Flour Co., San Francisco, Calif.

(Read at the convention June 2, 1925)

Our experimental baking test is the application of scientific methods to the fundamental process as used in the home and in the bakery. We weigh each ingredient, ferment under uniform conditions, bake at a uniform temperature, measure the size of the loaf, and express our results and observations of quality in mathematical or descriptive units. In spite of all our efforts to introduce science, the baking test as actually carried out still contains a large element of variation due to the art of the individual operator.

The object of this paper is to call attention to the necessity of scientific methods and to suggest a few further applications of them to our baking test, having in mind the substitution of science for the skill of the operator and the necessity of keeping within practical working conditions in flour mill laboratories. There are many tests that we would like to make, but lack of time requires that we perform only the most essential.

Preliminary

The first and most simple test that a chemist should make on flour is the "slicking test." From this a good opinion can be formed as to the color, extent of bleaching, clearness of milling, granulation, and to some extent as to the strength and character of the wheat used.

Ash and Gluten

The ash test will inform us as to the milling—whether patent, straight, or clear. We should then make a gluten washing, from which a good idea may be had of the strength and quality of the wheat; also the kind of wheat from which our sample of flour was milled. Each variety of wheat has its characteristic gluten quality, and, further, the soundness of the wheat has a marked influence on gluten quality. Hence, you will appreciate the value of making a gluten washing before starting the baking test. We should consider these preliminary deductions, however, as subject to confirmation later by the baking test.

Formula

Use only the essential ingredients so as to eliminate as many chances for variation as possible. Keep close to 3% sugar, 3% yeast, and 2% salt. We would not use shortening, as it is not essential and introduces complications. Shortening is very difficult to thoroly incor-

porate into a dough and may be the cause of a very uneven texture in the loaf.

Absorption

The amount of water absorbed by a flour is of great importance, not only the exact amount, but its resulting effect on the baking. If a flour is not given enough absorption, the fermentation will be hindered and the final appearance of the loaf will be rough and lack expansion. If given too much absorption, the fermentation will be too rapid and the loaf will have a coarse texture.

As an aid in getting the proper absorption, a glass plate is very convenient. After the loaf is mixed place the dough on a clean glass plate and note the manner in which it sticks to the plate on being pulled away. If too soft, some of it will stick to the plate. The proper absorption is indicated by the dough coming away clean and just to the point of sticking. This method is accurate to 1%, which is about as close as can be expected.

The official method for making the absorption test is to use only flour and distilled water. However, it is much more convenient for us to determine the absorption while mixing the dough for our baking, using tap water and all the ingredients. The following experiment made on two samples, one a strong flour, 12% protein, and the other a medium soft flour, 10% protein, indicates that the difference caused by tap water and ingredients are within the limits of experimental accuracy.

	No. 1 (Strong)	No. 2 (Soft)
Absorption	%	%
Flour alone and tap water.....	61.0	59.0
Flour, salt, sugar, yeast, and tap water.....	60.5	59.5
Fleur, salt, sugar, yeast, and distilled water.....	60.0	59.0
Flour, salt, and tap water.....	61.0	60.0
Flour, and distilled water.....	60.5	59.5

Fermentation

Proper and uniform fermenting conditions are extremely hard to secure and control. The first essential is to provide a supply of water of the right temperature for making up the dough. A large bottle, holding enough to make up as many doughs as you plan to mix each day, of the right temperature and held at that temperature by being immersed in warm water which has a constant supply of heat, is very convenient for this purpose. We use an automatic burette graduated

in percentage absorption, which is filled by suction from the supply bottle and so arranged that the water passes by a thermometer as it is drawn from the bottle to the burette.

A battery jar makes an excellent container during the fermentation period. The dough can be readily watched as it rises. The proper time for the first punch is best judged by observing the height, appearance of top, and lightness when touched with the finger. The latter is the generally accepted method.

A simple and valuable way to check the accuracy of your fermentation is by the use of methyl red indicator. This has a pH range of 4.4-6.0, and the average dough lies well up in the acid and red end of this indicator's range. A very convenient method is to put $\frac{1}{2}$ cc. of the indicator in each depression of a white porcelain chromate test plate, and at mixing, first punch, and moulding, put a little ball of dough in the indicator. As the fermentation progresses the acidity increases, producing a deeper shade of red in the methyl red. A mixture of methyl red and brown cresol purple can also be used. In the latter the purple fades and red develops as the acidity increases. Both indicators should be made very slightly alkaline, just sufficient to make the change more prominent. About five minutes is required for the full development of color if the piece of dough is simply dropped in. No attempt is made to determine quantitatively the actual acidity, but simply to judge from the depth of color the relative development of acidity in the different doughs, having in mind the initial acidity immediately after mixing. Patents will start with a relatively high acidity, straights next lower, and clears the lowest.

The first punch is most important, as thereafter the length of fermentation is a matter of judgment, governed by the strength and quality of the flour being tested.

Another advantage in using glass jars is that the gas cells formed during fermentation are easily observed. The nature of the cellular structure depends on the quality of the gluten. Strong flours with gluten of good quality have very fine cells. Soft and high patent flours have very fine and even cells. Clears are coarse and uneven.

Proper fermentation could be scientifically determined by an acidity and viscosity test made at a given point in the process, for instance when the dough is ready to divide into loaves. These two tests would indicate the development of the gluten and the acid conditions of the dough. They would give good information as routine tests in the bakery laboratory.

Temperature

The temperature of fermentation is extremely important and most difficult to control. Proofing cabinets very seldom maintain a uniform temperature throughout. Another complication is that doughs develop so much heat that their temperature is several degrees higher than the surrounding atmosphere. A 340-gram dough set at 80° in a proof box at 77° developed sufficient heat to overcome the natural loss of heat and in addition to raise the temperature of the dough to 82°. The same occurred whether doughs were set in glass jars or in pans. We also tried setting the glass jars in a water bath at 77° with the same result. Therefore, do not assume that your doughs are fermenting at 80° simply because a thermometer placed in the proof box indicates 80°. Uniform and proper fermenting temperature requires considering the actual temperature of the dough itself.

Proofing

One danger to avoid in proofing is too great an increase in temperature of the dough. While the loaf is being moulded the temperature will usually fall. A cold loaf placed in a warm proof box will ferment more rapidly on the outside, owing to the cold center. This will result in a poor loaf, having a fine, well developed texture on the outside and a coarse, uneven texture at the center.

Oven Spring

Oven spring is one of the most valuable characteristics of a good flour. The baking test must aim to show the relative amount of oven spring that a flour possesses. Proper fermentation and proofing are essential for the testing of oven spring. A large proofed loaf is not at all the equivalent of the same size loaf with oven spring. The oven should have a good reserve heat supply, proper moisture, and be capable of completing the baking period with a minimum of heat added during baking. A fire-brick oven floor is very desirable, if not essential.

Size of Pan

The loaf should give us as much information as possible, and still not vary too much from actual commercial practice. This requires a compromise of both, but we must not forget that it is always necessary to keep a firm foundation of actual practice under all our work. A 24-ounce loaf is easier to make than a 16-ounce loaf, and differences due to flour are minimized in the larger loaf. Therefore, for a baker the large loaf is the most satisfactory, but for the same reason the

16-ounce loaf is best for a testing laboratory. Another consideration is the shape of the pan. We should keep the loaf as near a commercial loaf as possible, and at the same time eliminate variation due to skill in moulding and unavoidable imperfect baking conditions. By the latter is meant the necessity of baking with the oven partially filled and opening the oven to add single loaves as they are ready. It is very difficult to have all perfectly formed loaves under such circumstances. A pan with sides a little higher than usual will assist very materially and still not vary much from commercial practice. A pan of the following dimensions is very satisfactory for a 340-gram formula or a loaf scaled at 18 ounces: top $3\frac{1}{2} \times 9$ inches; bottom $3\frac{1}{2} \times 8\frac{1}{2}$ inches; height $3\frac{1}{2}$ inches—all inside measurements, with the usual wire at the top. This pan avoids split and broken sides caused by position in the oven. It also is a very convenient size for most volume-measuring devices.

It might even be advisable to have a cover over the pans to further insure uniform moisture conditions and guard against flash heat.

Diastatic Power

A very simple method of determining the diastatic power of a flour is to bake it without sugar and salt. The comparative diastatic power is indicated by the outside appearance of the loaf. A very white crust is evidence of low diastatic power and a brown crust of an abundance of diastase. Many good strong flours would be much improved if their diastatic power were increased.

REPORT OF COMMITTEE ON STANDARD FORMULA AND METHOD OF PROCEDURE FOR EXPERI- MENTAL BAKING TESTS

By L. A. FITZ, *Chairman*

(Read at the convention June 2, 1925)

At the annual convention of the association held in Minneapolis, June 9 to 14, 1924, action was taken providing for the appointment of a committee for the purpose of investigating the possibility of a standard formula and method of procedure for experimental baking tests.

The plan was to have this committee selected to represent the various groups and interests among the membership. Provision was made for a representative from the United States Department of

Agriculture, from the American Institute of Baking, the American Society of Bakery Engineers, the Home Economics Association, the state experimental stations, the hard spring wheat district, the hard winter wheat district, the soft winter wheat district, and the Food Research Council.

Considerable delay was experienced in establishing the personnel of the committee owing to the fact that certain organizations either delayed taking action or did not take any action at all. Eventually the committee was appointed as follows:

L. A. Fitz, chairman; C. B. Morison, Raymond Hertwig, Leslie Olsen, C. A. Alsberg, R. S. Hermann, and L. D. Whiting.

After the completion of the committee, an attempt was made to get the views of the committee as to a suggested tentative formula and method of procedure. The chairman received responses from most of the members. After making a number of baking tests at the Fleischmann Laboratories, the chairman sent out the following formula and method of procedure to be used as a beginning, not with the idea that it might be wise even to adopt it as a tentative method without more or less modification.

Absorption Test

Weigh up 25 grams of flour into suitable porcelain cup, add sufficient distilled water, possibly 15 cc., mix thoroughly, work well into a dough-ball of uniform consistency, cover and let stand 30 minutes. Take out and work well in the hands until dough is smooth to determine if consistency is proper. When the requisite amount of water has been determined in this manner, the result should be checked by baking test as not all flours behave in the same manner when made into dough batch.

Ingredients—Formula

Flour	325 gms.	Pure lard.....	10 gms.
Sugar	12 "	Yeast	6½ "
Salt	5½ "	Distilled water.....	q. s.

Flour and dough temperatures should be 28° C., ferment at 28° C., proof at 35° C., bake at approximately 210° C. for 30 minutes.

Method of Procedure

Thoroughly dissolve sugar and salt in a portion of the water, yeast in another portion. Use water at a temperature to bring dough out at approximately 28° C. Add the solution to the flour, rinsing with balance of water then add the shortening in melted form. Mix thoroughly to a smooth dough. This may require from 3 to 10 minutes,

depending on type of mechanical mixer used. Remove the dough, fold into smooth dough ball and place in battery jar (6×8 inches), cover, place in dough cabinet maintained at 28° C. and let rise until ready to punch (determine this by thrusting a finger into the dough. Take it on the young side when it recedes only slowly), calculating this as 70% of the total time. Remove dough, work out gas well by folding in hands, return to jar to rise— $3/7$ of time required for first rise—then remove, work out gas well, as before, round up and replace in the jar for 12 minutes bench proof. Now mould into loaf, pan and proof to top of pan at 35° C.

Now place in oven. The loaf should be thoroughly baked after it has been in the oven for 30 minutes at 210° C.

Baking pans should be preferably 2 XX tinned iron and should have approximately the following dimensions: Top, $7\frac{1}{2} \times 4\frac{1}{2}$, bottom $7 \times 3\frac{1}{2}$, height $3\frac{1}{2}$ inches, and the ratio of pan volume to dough weight should be 3.2 to 1.

Consulting with a number of persons interested, developed the idea that it would be advisable to so arrange the formula that it would give approximately a one-pound loaf of bread upon baking and cooling.

The baking tests were made by most of the members of the committee until they became somewhat familiar with the formula and method of procedure. Later samples of flour were sent out so that the various members might compare results when working on the same flour.

As might be expected, the results confirmed what was already known, namely, that the technique of the operator or baker had a great influence upon the volume and texture of the loaf, even though everything else was as nearly controlled as was practicable. This is particularly true with respect to the last working of the dough and moulding of the loaf. However, in spite of these difficulties, the committee believes that progress has been made and that it is possible to lessen or reduce to the minimum the effect of this personal equation.

Your committee met as a body for the first time Monday, June 1, and spent a number of hours going over the whole matter. They make the following recommendations for a tentative standard formula for baking tests for hard wheat flour:

Flour	325 gms.	Yeast, compressed.....	10 gms.
Sugar	10 "	Pure lard.....	7 "
Salt (high grade).....	5 "	Distilled water.....	q. s.

Dough temperature 28° C., dough cabinet temperature 28° C., proof cabinet temperature 35° C., baking temperature 210° C., baking time, approximately 30 minutes.

It was recognized that distilled water is not ideal for baking purposes, but owing to the wide variations in the different types of water throughout the country, it was thought best to make our check tests with distilled water.

With respect to yeast, it is recommended that one pound cake of yeast be obtained as fresh as possible, direct from manufacturer and that all outside surfaces be trimmed off and discarded. Yeast for each loaf should be weighed up separately and added to a portion of water at the time of mixing of the ingredients.

We recognize the necessity of rather definite instructions as to methods of handling the dough or procedure and such recommendations of tentative method will be made to the committee continuing the work. The same thing may be said as to size and shape of baking pan with relation of dough weight to pan volume.

Definite directions for volume determinations and bread scoring must also be given in order that results may be properly interpreted and expressed. However, we do not feel that sufficient work has been done to enable us to make definite recommendations to the association at this time.

REPORT OF THE COMMITTEE ON METHODS

Submitted by C. E. MANGELS, Chairman

Agricultural Experiment Station, Fargo, N. D.

M. B. WARREN, C. B. KRESS, J. C. WOOD, C. H. BAILEY, G. A. SHUEY

General Report of the Committee by the Chairman

During the past few years the chemical laboratory has become of increasing importance in determining value and quality of grain and flour. The grain and flour trade today has a greater appreciation of the value of chemical tests than ever before.

The more extensive use and greater appreciation of the chemical laboratory is pleasing to the chemist, but with the increased use of the laboratory has come, necessarily, an increased responsibility. The trade demands—and rightly so—that the chemical laboratories obtain consistent and concordant results.

The majority of cereal chemists will probably agree when I state that the agreement between results obtained by different laboratories at present, leaves much to be desired. It is possible—that some of the methods we are now using, cannot from their very nature, be expected to give more concordant results. It is time, therefore, that we, as

chemists, take careful stock of methods we are now using for wheat and flour. What accuracy can we reasonably expect with chemical methods now in use? What can we do to increase the accuracy of these methods?

In order to obtain information and opinions regarding the methods now in use, a questionnaire was sent out to members of the American Association of Cereal Chemists and this report will deal particularly with information obtained from this questionnaire. The methods of greatest importance to the chemist at present are moisture, ash and protein.

Moisture

Question 1. How close should two laboratories be expected to check? Answers to this question ranged from .5% down to .1% with an average of .29% for all answers. In answer to question, what are good duplicates for moisture in flour, the replies ranged from .5 to .04 per cent, with an average of .15 per cent. The limit allowed between duplicates in laboratory practice before repeating work varied from .5 to .1 with an average of .23.

We certainly cannot expect different laboratories to check any better, or as well, as duplicates run in the same laboratory.

Some interesting data was obtained regarding the usual charge in ovens and dessicators. The number of dishes placed in the drying oven at a charge varied from 100 to 4, with an average of 15. The number of dishes placed in a dessicator at a charge varied from 44 to 4 with an average of 12. The dessicator charge was usually the same as the oven charge. The majority of chemists used an 8- or 10-inch dessicator, but sizes varied from 6 to 14 inches.

Heating a definite period of time was preferred to heating to constant weight—93% of the questionnaires favoring definite time. This is a point which should be considered, when moisture methods are rewritten.

Only 80% of those reporting were using covered dishes for moisture. The recent work of Smith and Mitchell shows the importance of covered dishes in preventing reabsorption of moisture while cooling.

The time of cooling before weighing showed surprising variation—the range being from 120 minutes to 2 minutes with an average of 35 minutes. While most questionnaires gave 30 minutes or under, the number using 45 and 60 minutes for cooling was surprisingly large. The methods for moisture usually state that the dishes should be cooled until they reach room temperature, but in view of the large variation in interpreting this direction, it would probably be advisable to specify a definite length of time.

Moisture results were reported to two decimal places by 73% of those answering questionnaire, the remainder reporting one decimal place.

Among the reasons for errors in moisture determinations were the following: Carelessness in weighing, sample not uniform, sample containers, absorption of water during weighing, absorption of water while cooling, incomplete drying, poor dessicator and time of cooling.

It is in order here, to call attention to the fact that real progress has been made in improving moisture methods for flour within the past two years. The controversy over moisture in flour and relation to regulatory measures in 1922, has been beneficial, since it has been responsible for considerable investigational work on the moisture method.

Snyder in 1922 called attention to the difference in results between vacuum oven and the old water oven methods. The writer as Referee on Cereal Foods for A. O. A. C. found variation due to different types of ovens. The published work of Snyder, Smith and Mitchell, and G. L. Spencer of the Bureau of Chemistry have added much to our knowledge of moisture in flour.

Ash

How close should two laboratories be expected to check on ash? Answers to this question ranged from .050 to .01 with an average of .018 for all replies. The majority of replies was .02. In answer to the question—what are good duplicates for ash—replies ranged from .05 to .002 with an average of .010. The limit between duplicates allowed before repeating ranged from .04 to .008 with an average of .015.

Three decimal places were reported for ash determinations by 60% of those answering questionnaire, the remainder reporting only two places. The pyrometer was believed to be essential for proper temperature control in 61% of questionnaires.

The questionnaires indicated that chemists apparently have less difficulty in securing concordant ash results than in case of protein or moisture. The principal objection to our present ash methods is the length of time required for the determination.

Protein

At the present time, the determination of protein is probably of greatest interest to the cereal chemist. The chemist has been subjected to considerable criticism due to the lack of concordant results obtained for protein in wheat. How close can two laboratories be expected to check on protein in wheat? The answers to this question ranged from .5 to .05 with an average of .24. Chemists generally agree that closer

checks could be secured on flour—replies ranging from .3 to .05 with an average of .17. Chemists opinion as to what constitutes good duplicates for protein in wheat ranged from .5 to .05 with an average of .15; for flour the range was .3 to .03 with an average of .12. The limit allowed between duplicates before repeating the work ranged from .5 to .08 with an average of .21.

Practically all chemists answering questionnaire considered protein more accurate than the old washed gluten test—in some cases, the replies were quite emphatic. In answer to question—How close can laboratories check on gluten—opinions varied—replies ranged from 5 to 10 per cent wet gluten and 3 per cent to .2 per cent for dry gluten with an average of .99 dry gluten variation. Cereal chemists evidently do not consider the washed gluten test as satisfactory for control work.

Only 48 per cent of chemists reported that they *always* ran protein tests in duplicate. In reporting results 90% used two decimal places, while remainder reported one decimal place. Practically all chemists answering questionnaire, ground and mixed wheat samples before analysis.

Causes of error: Incorrect standard solutions was given as cause of error by many chemists, and following were improper or insufficient digestion, improper grinding or mixing of sample, sample not representative, variation in moisture content of sample and also leaky and dirty stills, inaccurate burettes, incorrect b'anks, and two or three thought carelessness and incompetence principal cause of error. One chemist mentioned creeping of alkali as a source of error..

In regard to the creeping of alkali, it is presumed that the bulb traps used in Kjeldahl distillation prevent this, but the writer has found that a too great concentration of alkali will often cause erratic results. A very slight excess of alkali gives most concordant results.

Care in standardizing titrating solutions is essential. The use of potassium acid phthalate as suggested by Coleman et. al. for checking standardization should receive careful consideration. The writer uses an exactly N/14 sulphuric acid solution. Recently the following practice of standardization has been followed in the laboratory. The acid is first roughly standardized against the old acid. Then in order to obtain correct strength, acid is standardized by adding ammonia, evaporating and weighing as ammonium sulphate. This procedure is much quicker than the barium sulphate method. When acid of desired strength (exactly N/14) has been secured by the ammonium sulphate method—a final standardization is made by the barium sulphate method—thus giving two checks on the acid.

Careful grinding and mixing of samples is essential and the recent article of Coleman et. al. contains some valuable information on this point.

Chemists evidently do not realize the importance of reporting wheat proteins on a common moisture basis. In answering the questionnaire, some stated that the difference in moisture content of wheat as it comes into the market was not sufficient to greatly affect the protein content. The writer begs leave to disagree. A sample of wheat containing 12.50% moisture and 13.00% protein as received, will contain only 12.85% protein on 13.5% basis. Wheat coming into the market will very often show 2% or greater variation in moisture content and this means a difference of .3% protein. The writer recently analyzed a sample of wheat which contained 11.1% protein on an as received basis, but only 10.3% when calculated to 13.5% moisture basis. This sample contained only 6.7% moisture. While this difference of 0.8 may be unusual, it might occur and be the cause of chemists in general receiving rather caustic criticism. Let us take a hypothetical case. A sample is taken from a car of wheat and sent to a laboratory for analysis—and the wheat as taken from the car contains about 12.5% moisture. The party sending the sample is not satisfied with the results of the test—(11.00 per cent) and sends another portion of the sample, which he has retained at his office to another laboratory. This wheat sample meanwhile has been kept in a warm room in a paper envelope or a sack, and possibly near or on top of a radiator and the second laboratory returns a higher result. (11.57), because sample then only contains 8.00 moisture.

It has been the policy of the Methods Committee to co-operate with the A. O. A. C. in improving cereal methods. The methods of the A. O. A. C. are recognized as standard and it would not be desirable to set up two standards. By co-operation, we can secure revision and improvement in A. O. A. C. methods, along lines desired by cereal chemists.

The following changes were made in A. O. A. C. methods at the 1924 convention.

The ash method recommended by C. H. Bailey in 1922 was finally adopted by the A. O. A. C. last year as the official method for ash in flour.

The moisture method was amended by dropping the words "in a current of dry hydrogen," so that the official method now provides for drying in vacuo only.

Collaborative Work on Protein in Cereals

By M. B. WARREN

In the collaborative work on nitrogen this year, we decided to study it from a little different angle than any previous year. We had hoped to throw a little light on the subject by comparing the length of digestion time with the loss of weight. The following method and precautions were taken:

Weigh up one gram sample of wheat and place in 500 cc. Kjeldahl flask, add 6.5 grams sodium sulphate, 0.7 grams mercuric oxide and 25 cc. of sulphuric acid, insert a stopper and weigh; then remove stopper, shake till no part of the sample sticks to the sides or bottom and no lumps appear on the surface of the acid. Place on heater and digest for 15 minutes, remove from heater and connect neck of Kjeldahl flask with a calcium chloride tube to prevent absorption of moisture from the air during cooling; when at room temperature replace calcium chloride tube with the stopper used previously in weighing, and weigh.

Use the same precautions as above and run eight determinations on each sample, digesting the first 15 minutes, second 30 minutes, third 45 minutes, fourth 1 hour, fifth 1 hour and 15 minutes, sixth 1 hour and 30 minutes, seventh 1 hour and 45 minutes and the eighth 2 hours, weighing each one before and after digesting and report loss in grams. Then proceed with the usual distillation process.

Also in the same way run eight blank determinations, digesting the first 15 minutes, second 30 minutes, third 45 minutes, fourth 1 hour, fifth 1 hour and 15 minutes, sixth 1 hour and 30 minutes, seventh 1 hour and 45 minutes and the eighth 2 hours, to determine what corrections, if any should be applied to each determination due the ammonia present in reagents used. Weigh the blanks in the same way as on the wheat samples.

Heating during the digestion period should be maintained as nearly uniform as possible on all digestions.

Also determine the nitrogen in a one-gram sample of ferrous ammonium sulphate, $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot 6\text{H}_2\text{O}$, or Mohrs salt (report as $\text{N} \times 5.7$) using the same amounts of chemicals as in the protein determination on the wheat and digesting for a two-hour period and also run same *without any previous digestion*.

The loss of weight during digestion should show the strength and uniformity of the heat used and should also show the change in the boiling point. We also wanted to see if the maximum results on the wheat samples were reached at the same time as the maximum loss of

weight and if the results throughout digestion were in proportion to the loss of weight.

The Mohrs salt would furnish us an index as to the relative strengths of the standard acid used by all the collaborators, also possible losses occurring during digestion.

We find the maximum result is not reached *in less than forty-five minutes*, only one of the eleven collaborators completing it in that time, also there was no ratio of protein to loss of weight. *Seventy-five minutes seems to be the average maximum for digestion*, but even then, three collaborators did not complete the maximum in less than two hours. The result of the study of digestion period are recorded in Table I.

TABLE I
TIME OF DIGESTION REQUIRED TO SECURE MAXIMUM PROTEIN CONTENT

Maximum reached on sample No. 1

1	Collaborators in	45	minutes
2	"	60	"
3	"	90	"
1	"	105	"
2	"	120	"
<hr/>			
		9	

Sample No. 2

1	Collaborators in	60	minutes
2	"	75	"
4	"	90	"
1	"	105	"
3	"	120	"
<hr/>			
		11	

Sample No. 3

2	Collaborators in	60	minutes
6	"	75	"
1	"	90	"
2	"	120	"
<hr/>			
		11	

There seems to be no correlation (compare Tables IV and V) as to maximum loss of weight and maximum protein results; one or two collaborators show a gradual increase, the rest of them show large variations, probably due to the kind of heat used and also its uniformity during digestion.

The maximum increase in protein from the 15-minute digestion period on the three samples of wheat was 1.78% and the minimum was .20%.

Table II shows the actual increase in percentage in protein from the 15-minute digestion period until the maximum result is obtained.

TABLE II
INCREASE IN PERCENTAGE OF PROTEIN FROM THE 15-MINUTE DIGESTION PERIOD TO THE MAXIMUM OBTAINED

Collaborators Nos.	Sample No. 1	Sample No. 2	Sample No. 3
1	1.78	.96	1.22
2	1.34	.86	1.35
3	1.12	1.06	1.74
4	.40	.24	.44
5	.40	.44	.48
6	.65	.35	.30
7	.20	.50	.40
8	.44	.24	.36
9	.36	.24	.40
10	.94	.63	.81
11	.65	.93	.72

The Mohrs salt results recorded in Table III show that there is no loss of nitrogen during digestion. Taking the average of Mohrs salt and the average of the wheat sample to be correct, we feel that those striking one average should strike the other; therefore, those being high on one should be high on the other and vice versa. Referring to the data in Table III the data underscored seem to follow the rule.

TABLE III
NITROGEN CALCULATED AS PROTEIN REPORTED BY 11 COLLABORATORS IN A SAMPLE OF MOHRS SALT AND IN 3 WHEAT SAMPLES

Collaborator number	Mohr salt sample No. 1 digesting 2 hours	Wheat sample No. 1	Wheat sample No. 2	Wheat sample No. 3
1	40.54	12.84	11.13	13.80
2	40.7	13.05	11.21	14.05
3	40.78	12.69	10.95	13.89
4	40.4	12.84	11.02	13.98
5	40.69	13.03	11.0	13.99
6	40.0	12.65	10.8	13.7
7	40.55	12.9	11.3	14.0
8	39.82	12.74	11.09	13.86
9	40.24	12.52	10.84	13.64
10	40.25	12.65	11.02	13.81
11	40.7	12.70	10.85	13.80
Average	40.42	12.78	11.03	13.87

One of the collaborators did not seem to follow the rule in any instance on the three wheat samples. The wheat protein results of collaborators Nos. 3 and 11, according to their Mohrs salt result, should run a little high, but in each case they ran low.

Collaborator No. 8 shows a low Mohrs salt result, but the protein results strike the average.

All the other collaborators appear to follow the rule with a few exceptions on all three wheat samples. These possibly may be technical errors.

In summing up the work, we feel that the time for digestion should be two hours, as this length of time will cover all losses and one can feel sure that the results are accurate.

We conclude from the report that the variations in loss of weight were probably due to the type of heat used and its uniformity during digestion.

The Mohrs salt results seem to indicate that the standard acid used by all collaborators was probably not up to standard, and serves well in checking results.

TABLE IV
LOSS IN WEIGHT OF FLASK CONTENTS DURING DIGESTION

Collaborators	15 Min.	30 Min.	45 Min.	1 Hour	1 Hour, 15 min.	1 Hour, 30 min.	1 Hour, 45 min.	2 Hours
Loss of weight in grams after digesting wheat sample No. 1								
1	4.3	9.8	10.6	11.8	12.6	13.3	13.6	13.95
2	6.75	9.00	9.05	10.25	9.20	9.35	10.53	12.0
3	6.45	9.05	9.4	8.9	9.45	9.5	9.55	9.35
4	10.7	11.5	12.0	12.3	12.9	13.2	13.4	13.8
5	10.0	11.8	12.5	14.7	15.2	18.0	18.0	16.8
6	10.3	11.7	12.1	11.2	13.0	13.5	13.5	13.5
7	10.5	11.4	12.4	13.1	14.3	14.3	14.5	14.1
8	10.6	10.3	10.6	11.4	12.4	12.7	12.6	12.7
9	10.0	12.0	12.0	15.0	18.0	8.0	16.0	13.0
10	10.0	12.0	13.0	13.0	14.0	14.0	15.0	17.0
11	10.0	11.1	10.9	10.8	9.8	12.5	14.8	15.0
Average	9.05	10.88	11.32	12.04	12.80	12.57	13.77	13.75
Maximum	10.7	12.0	13.0	15.0	18.0	18.0	18.0	17.0
Minimum	4.3	9.0	9.05	8.9	9.20	8.0	9.55	9.35
Loss of weight in grams after digesting wheat sample No. 2								
1	5.3	9.7	11.3	12.2	12.2	12.4	13.6	14.4
2	6.5	8.4	9.3	9.65	9.6	10.2	9.45	9.85
3	7.0	10.0	11.0	11.0	10.85	11.4	11.25	12.4
4	9.9	10.9	11.5	12.8	13.2	13.5	14.4	14.8
5	10.8	12.5	13.6	14.2	16.7	16.6	19.0	19.2
6	9.3	10.7	13.1	13.2	13.4	12.8	15.5	16.1
7	9.7	10.4	10.5	11.2	12.4	13.9	13.2	15.8
8	10.4	10.2	10.5	10.5	10.8	11.1	12.1	12.1
9	6.0	14.5	24.0	18.0	18.0	20.0	18.5	16.5
10	11.0	11.0	13.0	13.0	13.0	15.0	15.0	17.0
11	9.1	10.2	10.7	11.6	9.6	14.1	12.6	11.2
Average	8.63	10.8	12.6	12.48	12.70	13.7	14.06	14.5
Maximum	11.0	14.5	24.0	18.0	18.0	20.0	19.0	19.2
Minimum	5.3	8.4	9.3	9.65	9.6	10.2	9.45	9.85

TABLE IV—*Continued*
LOSS IN WEIGHT OF FLASK CONTENTS DURING DIGESTION

Collaborators	15 Min.	30 Min.	45 Min.	1 Hour	1 Hour, 15 min.	1 Hour, 30 min.	1 Hour, 45 min.	2 Hours
Loss of weight in grams after digesting wheat sample No. 3								
1	5.8	10.0	10.8	10.4	11.6	11.8	13.2	14.4
2	9.4	9.55	9.8	9.4	10.45	11.6	11.2	10.65
3	5.65	9.95	11.6	11.3	10.6	11.3	10.75	11.8
4	15.1	16.4	16.8	17.8	18.4	18.6	18.9	21.1
5	11.6	13.0	12.9	15.1	15.3	16.7	18.5	20.3
6	10.0	10.3	12.4	13.4	11.4	14.0	16.0	12.6
7	10.0	10.9	10.1	10.1	10.7	10.4	11.1	10.9
8	10.4	10.2	10.2	10.2	10.2	10.2	9.3	10.2
9	5.5	15.0	24.0	24.0	24.0	20.0	12.0	19.5
10	10.0	12.0	12.0	13.0	13.0	15.0	15.0	17.0
11	8.8	11.0	11.0	12.0	10.0	14.6	12.5	12.2
Average	9.3	11.7	12.9	13.3	13.24	14.0	13.5	14.6
Maximum	15.1	16.4	24.0	24.0	24.0	20.0	18.9	21.1
Minimum	5.5	9.55	9.8	9.4	10.0	10.2	9.3	10.2
Loss of weight in grams after digesting blanks								
1	2.6	2.6	2.8	3.9	4.3	5.2	5.2	5.4
2	1.2	2.05	....	....	....	....	1.8	2.5
3	1.28	2.95	4.45	5.05	4.45	5.05	4.7	8.0
4	2.9	4.3	5.0	5.6	6.2	6.2	8.1	9.0
5	3.2	4.2	5.2	7.5	6.3	8.7	8.1	8.8
6	4.9	5.7	6.7	3.6	4.4	8.0	9.2	8.0
7	3.7	3.7	5.0	3.9	3.4	3.1	3.2	4.3
8	9.5	10.0	9.8	10.2	10.0	10.2	10.9	10.4
9	2.5	3.0	3.0	8.0	3.0	16.0	4.0	8.0
10	4.0	4.0	7.0	6.0	6.0	9.0	9.0	11.0
11	1.7	1.0	2.2	5.2	3.2	10.5	9.2	9.6

TABLE V
PROTEIN RESULTS WITH DIFFERENT TIME OF DIGESTION

Collaborators	15 Min.	30 Min.	45 Min.	1 Hour	1 Hour, 15 min.	1 Hour, 30 min.	1 Hour, 45 min.	2 Hours
Protein results sample wheat No. 1								
1	11.06	12.35	12.54	12.64	12.70	12.70	12.84	12.84
2	11.91	12.77	12.85	12.8	13.25	13.25	13.05	13.05
3	11.57	12.49	12.65	12.61	12.65	12.65	12.65	12.69
4	12.52	12.70	12.90	12.92	12.90	12.86	12.86	12.84
5	12.63	12.71	13.03	13.03	13.03	12.95	13.03	13.03
6	12.0	12.4	12.5	12.5	12.55	12.65	12.65	12.65
7	12.7	12.8	12.7	12.9	12.8	12.8	12.8	12.9
8	12.3	12.45	12.60	12.61	12.61	12.67	12.66	12.74
9	12.28	12.49	12.49	12.56	12.64	12.60	12.52	12.52
10	11.9	12.53	12.69	12.69	12.61	12.61	12.84	12.65
11	12.3	12.38	12.53	12.70	12.95	12.70	12.70	12.70
Average	12.1	12.55	12.68	12.72	12.79	12.76	12.78	12.77
Maximum	12.7	12.80	13.03	13.03	13.25	13.25	13.05	13.05
Minimum	11.06	12.35	12.5	12.5	12.55	12.60	12.52	12.52

TABLE V—Continued

PROTEIN RESULTS WITH DIFFERENT TIME OF DIGESTION

Collaborators	15 Min.	30 Min.	45 Min.	1 Hour	1 Hour, 15 min.	1 Hour, 30 min.	1 Hour, 45 min.	2 Hours
Protein results sample wheat No. 2								
1	10.17	11.05	10.86	11.05	11.05	11.13	11.13	11.13
2	10.43	10.91	11.14	11.14	11.24	11.29	11.25	11.21
3	9.99	10.95	10.99	10.95	10.99	10.99	10.99	10.95
4	10.82	10.94	10.98	10.92	11.02	11.06	11.04	11.02
5	10.6	10.8	10.96	11.0	11.04	11.04	11.0	11.0
6	10.5	10.7	10.7	10.8	10.85	10.8	10.8	10.8
7	10.9	10.8	11.0	11.0	11.2	11.1	11.2	11.3
8	10.85	10.93	11.01	11.08	11.02	11.00	11.01	11.09
9	10.6	10.76	10.76	10.84	10.80	10.80	10.84	10.84
10	10.47	10.86	10.94	10.94	10.90	11.10	11.02	11.02
11	10.2	10.93	10.85	10.85	11.00	11.0	11.1	10.85
Average	10.5	10.87	10.92	10.96	11.01	11.02	11.03	11.03
Maximum	10.9	11.05	11.14	11.14	11.24	11.29	11.25	11.30
Minimum	9.99	10.7	10.7	10.8	10.80	10.80	10.80	10.80

Protein results sample wheat No. 3

	12.58	13.53	13.53	13.80	13.80	13.80	13.63	13.80
1	12.85	13.65	13.97	13.98	14.2	14.2	14.1	14.05
2	12.15	13.65	13.78	13.81	13.77	13.84	13.84	13.89
3	13.58	13.74	13.94	13.94	14.02	13.94	14.02	13.98
4	13.63	13.95	13.99	13.99	14.11	14.08	13.99	13.99
5	13.4	13.55	13.6	13.7	13.6	13.7	13.7	13.7
6	13.7	13.7	13.9	13.9	13.9	14.1	13.8	14.0
7	13.50	13.55	13.64	13.76	13.72	13.70	13.80	13.86
8	13.24	13.48	13.60	13.60	13.64	13.64	13.64	13.64
9	13.12	13.70	13.81	13.81	13.93	13.77	13.89	13.81
10	13.08	13.57	13.73	13.73	13.80	13.80	13.80	13.80
Average	13.16	13.64	13.77	13.82	13.86	13.87	13.83	13.87
Maximum	13.7	13.95	13.99	13.99	14.2	14.2	14.1	14.05
Minimum	12.58	13.48	13.53	13.60	13.6	13.64	13.63	13.64

Blank results

TABLE V—Continued

Collaborator	Mohr's salt sample No. 1	Without digestion	Collaborator	Mohr's salt sample No. 2	Without digestion
	Digesting 2 hours			Digesting 2 hours	
1	40.54	40.54	1	40.54	40.54
2	40.7	40.77	2	41.17	41.01
3	40.78	.....	3	40.78	.....
4	40.4	.....	4	.....	.....
5	40.69	40.85	5	40.85	40.89
6	40.0	40.42	6	40.25	40.3
7	40.55	40.55	7	40.65	40.65
8	39.82	39.82	8	39.74	39.74
9	40.24	40.24	9	39.84	39.92
10	40.25	.....	10	40.25	40.10
11	40.7	.....	11	40.8	.....
Average	40.42	40.45	Average	40.48	40.4

Collaborative Work on Ash Methods

By J. C. Wood

The problem in the determination of ash at present is to find a method that is accurate but less time-consuming than present official method.

The Bailey-Hertwig or the glycerol method was subjected to further collaborative study.

Mr. Hertwig kindly furnished the committee with a copy of the revised glycerol method as published in Cereal Chemistry for January, 1925, which is as follows:

Apparatus and Reagent

Flat bottom ashing dish of platinum, porcelain or silica; breadth approximately 5 cm.; depth 1 to 1.5 cm.

Air tight dessicator containing reignited quick-lime or calcium carbide.

Glycerol-alcohol solution made from equal volumes of ash free redistilled glycerol and alcohol (95% by volume).

Determination

Weigh 5 grams of flour into an ashing dish which has previously been ignited, cooled in the desiccator and weighed soon after room temperature has been attained. Mix the flour with 6 cc. of the glycerol-alcohol solution, and distribute the mixture evenly about the dish. Clean the mixing rod with a small piece of ashless filter paper and add to the dish. Transfer immediately to a furnace held at approximately 550 degrees C. (dull red), or if preferred, ignite the alcohol and allow to burn off before placing in the furnace. Ignite the

vapors and leave the furnace door open until flaming ceases. Incinerate to a light gray ash and transfer to the dessicator, weighing soon after room temperature has been obtained. Correct for any blank obtained from the quantity of the glycerol-alcohol solution used should no ash free glycerol be obtainable.

To study the time consumed we specified to weigh at the end of 1½ hours, 2 hours, and 2½ hours and longer if found necessary.

It was specified to report time, ash per cent, color of ash and also temperature if it deviated from the prescribed figure, also criticisms and conclusions regarding the method. The sample also to be ashed by the official method with the same report.

Sample I was sent to collaborators with instructions to follow Bailey-Hertwig and the official methods in detail.

After receiving the results on the first sample in which the Bailey-Hertwig method was followed in detail, it was suggested that the larger sample (5 grams) required a longer period of incineration than a smaller sample of 3 grams. Acting on this suggestion two samples were sent out: No. 2, a hard wheat patent, and No. 3, a soft wheat clear. The Bailey-Hertwig method was to be followed with the one exception that three gram sample be used instead of five, with a corresponding decrease in the glycerol-alcohol solution. Also a sample was to be run by the official method. (Official method with smaller amount of sample.) These samples were to be weighed at the end of 1½, 2, 2½, 3 and 3½ hours, and longer if necessary.

No specification was made as to kind of dish to be used other than size called for by the method.

Results

Sample I. The maximum variation between the results reported by six collaborators on the Bailey-Hertwig method is .008%, and on the official method is .029%. There was quite a variation of time of incineration in following the official method, which probably accounts for the wider variation in results.

Samples II and III. On sample II the average percentage of ash as determined by the Bailey-Hertwig method is .428%, and by the official method .426%. The average time on the Bailey-Hertwig method to obtain the minimum is 4.1 hours, the official method here required a slightly shorter time. However, some of the collaborators did not follow the time at half hour intervals and the above figure taken from the results of three men probably is not representative.

The same comments apply to sample III as can be seen from the data.

Comments by Collaborators

No. 5. No time was saved by the Bailey-Hertwig method as our results show, although this can be partly accounted for by the larger sample used in this method, and therefore more time being required for complete incineration. Our criticism of this method is that very little time is saved, and the sample tends to run over the sides of the crucibles when first put in the furnace.

On second samples in which three grams of sample was used this comment is made, "It is evident from our experience that the Bailey-Hertwig method does not save any time over the usual method, therefore we prefer the latter."

No. 4. My greatest objection to the Bailey-Hertwig method is that the crucibles leak when they appear to be free from cracks. From my experience with the method I do not think that I can save time.

No. 6. Fail to see where any time is saved when you have a number of samples to run.

No. 3. Our conclusion on the Bailey-Hertwig method is: It is possible to save 1 to 2 hours on the actual burning of the ash, but that it is considerable trouble in preparing the samples when a large number are to be run, also we would have to install a larger muffle furnace if we were to use this method in our routine work. Everything considered we would prefer to use our usual method to the Bailey-Hertwig method.

Conclusions

The Bailey-Hertwig method is accurate and gives reliable results. Very little, if any, time can be saved. Type of crucible recommended cuts down capacity of muffle. Time of the chemist is consumed in preparing samples for muffle.

There seems to be no reason why this method should be recommended for adoption other than as an optional method.

TABLE VI
RESULTS OF COLLABORATIVE ASH DETERMINATIONS BY THE BAILEY-HERTWIG AND THE OFFICIAL A. O. A. C. METHODS

Time in hours	Official method	Collaborator number						Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method
		1	2	3	4	5	6									
1½536D	....	....	....	....	....	.555B	....	....	....	1.056	....	....	....	.650B
2524LG	....	....	....	....	....	.543DG	....	....	....	.645	....	....	....	.550DG
2½525LG	....	....	....	....	....	.537LG	....	....	....	.550	....	....	....	.535DG
3520G
3½520LG	....	....	....	.....	....	....	....	.....
4
5½
8
		.532	....	....	....	....	....	.525	....	....	....	.503	....	....	....	.515

D, dark; LG, light gray; B, black; DG, dark gray; GW, gray white; G, gray.

Time in hours	Bailey- Hertwig method	Sample No. 1						Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method	Official method	Bailey- Hertwig method	
		1	2	3	4	5	6										
1½528	11.043B	11.719B	.....	.....	.....	.483B	.....	.503B	.....	.570B	.....	.....	.....	.620	
2476	6.583B	.990B	.....	.....	.....	.436DG	.....	.447DG	.....	.446B	.....	.....	.....	.480	
2½447	2.673B	.518B	.....	.....	.....	.430G	.....	.443DG	.....	.440B	.....	.....	.....	.440	
3433	.563B	.....	.....	.....	.433DG	.....	.430G	.....	.440DG	.....	.....	.....	.437	
3½424	.442B	.....	.....	.....	.426LG	.....	.431G	.....	.430G	.....	.....	.....	.433	
4424	.433B	.....	.....	.....	.....	.....	.....	.....	.433DG	.....	.....	.....	.....
4½430LG	.....	.....	.....	.....
5	
B-H method									Official method								
Maximum431
Minimum420
Range011
Average425

B-H = Bailey-Hertwig glycerol method.

TABLE VI—Continued
Sample No. 3

Time in hours	2		3		4		5		6	
	Bailey- Hertwig method	Official method								
1½545B	.566B	.540B	.783B965
2512494DG	.543DG	.485B	.516DG692
2½493485G	.502DG	.480B	.493DG525
3488480G	.490G	.480DG	.486LG500
3½481	.527B	.507DG	.480G	.480G	.486LG498
4481480DG	.486LG
4½480G	.486LG
5472DG	.470LG493	...
B.-H. method										
Maximum498493
Minimum470472
Range028021
Average483481

B.-H. = Bailey-Hertwig method.
B, black; DG, dark gray; G, gray; LG, light gray.

Recommendations of the Methods Committee

The following recommendations were approved by the convention.
It is recommended :

1. That the chairman of the Methods Committee be empowered to appoint the other members of the committee. Each appointee on the committee to be assigned a specific problem, and the number serving on the committee be left to the discretion of the chairman.
2. That the chairman of the Methods Committee, or at least one member of the committee be in a position to attend the A. O. A. C. convention in Washington.
3. That in order to secure uniformity, chemists are requested to report 2 decimal places for moisture, 3 decimal places for ash, and 2 decimal places for protein. It is understood that the last decimal place in all three cases is only approximate.
4. That on the basis of present analytical methods a tolerance between two different laboratories of 0.3% on moisture, when using same method, 0.02% in ash, and 0.25% on protein when calculated to uniform moisture basis is allowable.
5. That methods for moisture specify a definite time of heating rather than heating to constant weight, and directions for cooling in desiccator be made more specific as to time.
6. That the committee study collaboratively the different methods of standardizing acids for Kjeldahl determinations.
7. That the committee study effect of temperature and time on the capacity of boric acid to fix ammonia.
8. That the committee study collaboratively the determination of viscosity in flours.
9. That the committee study the sampling, grinding and preparation of wheat samples for analysis—such studies to include :
 - (1) Comparison of different types of laboratory mills.
 - (2) Degree of fineness of grinding.
 - (3) Method of mixing after grinding.
 - (4) Relation of moisture variation to protein results.

MINUTES OF ELEVENTH ANNUAL CONVENTION OF THE
AMERICAN ASSOCIATION OF CEREAL CHEMISTS

By R. K. DURHAM, *Secretary-Treasurer*

Statler Hotel, St. Louis, Mo.

June 1 to 6, 1925

MONDAY, JUNE 1, 1925

Meeting called to order at 11:15 a. m. at Statler Hotel by President M. J. Blish.

Opening address by president.

Appointment of committees.

Resolutions committee: L. R. Olsen, chairman; A. A. Jones, L. H. Bailey.

Nominating committee: M. R. Warren, chairman; C. E. Mangels, H. E. Weaver.

Announcements.

Meeting adjourned by motion at 11:45 a. m.

TUESDAY, JUNE 2, 1925

Meeting called to order at Statler Hotel at 9:20 a. m. by President Blish.

Following question box committee appointed: H. E. Weaver, chairman; Rowland Clark, L. H. Bailey, C. G. Harrel, L. D. Whiting.

Baking committee report by Chairman L. A. Fitz.

Moved report be accepted. Seconded.

Moved as an amendment that present committee continue the work. Seconded, carried.

Original motion as amended carried.

Baking committee made up of the following: L. A. Fitz, chairman; United States Department of Agriculture, Raymond Hertwig; American Association of Home Economics, Alice M. Child; American Institute of Baking, C. B. Morrison; Agricultural Experimental Stations, M. J. Blish; Hard Spring Territory, Leslie R. Olsen; Hard Winter Territory, R. S. Herman; Soft Wheat Territory, L. D. Whiting; Pacific Coast Territory, C. L. Alsberg.

Paper—"The Baking Test," by E. E. Werner.

Paper—"A Theory of Colloidal Behavior in Dough," by C. O. Swanson.

Paper—"The Sugar Content of Bread," by C. B. Morrison.

Paper—"The Effects of Diastase and Malt Extract in Bread Doughs," by F. A. Callatz.

Paper—"More Science in Experimental Baking," by C. B. Kress.

Meeting adjourned by motion at 12:45 p. m.

WEDNESDAY, JUNE 3, 1925

Joint meeting of Association of Operative Millers and American Association of Cereal Chemists called to order by President Fredel.

Address by Sidney Anderson.

Address by M. J. Blish.

Address by P. H. Lawson.

Adjourned to convention room.

Reading of communications.

Moved that we dispense with reading of minutes. Seconded, carried.

Reports of committees.

Report of Secretary-Treasurer, R. K. Durham.

REPORT OF THE SECRETARY-TREASURER OF A. A. C. C.

By R. K. DURHAM

(Read at the convention June 3, 1925)

We have just come to the end of another year that is marked with the usual steady addition of new members, new subscribers and increased bank balance. All this success may be attributed to the publicity the association has received through its publication, *Cereal Chemistry*. And this is in turn due very largely to the efforts of Dr. C. H. Bailey, editor-in-chief, and to Mr. C. G. Ferrari, managing editor, who have filled the official publication with high class scientific material and have secured almost enough advertising to pay costs of printing.

The association has 244 members and 190 subscribers who are distributed on every continent in the world. Forty-eight new members have been added during the year. Forty old members have been dropped for various reasons and one deceased. Thus the total membership shows an increase of only 7. It is notable, however, that all members listed are in good standing, whereas, all previous reports of the secretary-treasurer showed at least 50 per cent of members delinquent in dues. It may seem a drastic measure to drop 40 members, many of whom had been members for years, but it is only fair to those who pay dues promptly. Furthermore, post office requirements are such that we are allowed only a very small gratuitous mailing list. In our case this number is almost filled with exchanges and advertisers.

At the end of last fiscal year our membership was divided as follows: Active, 191; associate, 12; sustaining, 32; honorary, 2; total, 237. Now we have active, 195; associate, 12; sustaining, 36; honorary, 1; total, 244.

Two years ago when the present Secretary-treasurer took over the books there was a balance barely sufficient to meet all outstanding bills. Now, as shown by the following financial statement we have a balance of \$2,462.25.

FINANCIAL STATEMENT

OF

Secretary-Treasurer A. A. C. C.

May 25, 1925

RECEIPTS

Cash on hand June 7, 1924.....	\$1,440.57
Application fees and membership dues.....	1,783.75
Subscriptions to <i>Cereal Chemistry</i>	641.28
Advertising in <i>Cereal Chemistry</i>	1,290.55
Sale of back journals and methods of analysis.....	24.84
Miscellaneous	152.27
 Total receipts.....	\$5,333.26

EXPENDITURES

Editing, printing and mailing <i>Cereal Chemistry</i>	\$2,369.98
Secretarial supplies, etc.....	176.10
Convention expenses.....	165.25
Miscellaneous	159.68
 Total expenditures.....	\$2,871.01
Cash on hand May 25, 1925.....	2,462.25
 \$5,333.26	

ASSETS	
Cash on hand.....	\$2,462.25
Unpaid advertising.....	310.30
Total assets.....	\$2,772.55
LIABILITIES	
Stanford Food Research loan.....	\$200.00
Total liabilities.....	\$200.00
CREDIT BALANCE.....	\$2,572.55

Moved report be accepted. Seconded, carried.

REPORT OF THE MANAGING EDITOR

By C. G. FERRARI

(Read at the convention June 3, 1925)

Of the miscellaneous statistics that might be submitted concerning the activity of the journal from June 1, 1924, to June 1, 1925, the following may be of interest:

At present 436 journals are mailed of each issue to members and subscribers. This number does not include a single one whose subscription or membership is not paid. The distribution of this number is as follows:

- Domestic members, 184.
- Foreign members, 23.
- Sustaining members, 36.
- Domestic subscribers, 118.
- Foreign subscribers, 72.
- Advertisers and exchanges, 22.

Foreign membership is held in the following countries: Canada, Argentine, Scotland, England, Germany, Sweden.

Foreign subscriptions are scattered in foreign countries as follows: Sweden, Australia, Holland, Norway, Spain, France, South Africa, Western Australia, Japan, Germany, Canada, Ireland, England, Scotland, Brazil.

Sustaining membership to the number of thirty-five is held by firms or individuals in Japan, Canada, England, Belgium, and the United States.

It is a matter of regret that 77 were retired from the list of members and subscribers chiefly for non-payment of subscriptions and dues. Some few were removed because mail failed to reach them and the managing editor was not advised of the change in address.

Aside from income received from membership, sustaining membership, and subscriptions the total income received through advertisers in the journal from June 1, 1924, to June 1, 1925, is \$1,325.30.

Moved report be accepted. Seconded, carried.

Report of Resolutions Committee, L. R. Olsen, Chairman.

REPORT OF RESOLUTIONS COMMITTEE

WHEREAS, The American Association of Cereal Chemists, in session June 1 to 6, 1925, at Hotel Statler, St. Louis, Mo., recognizing that the success of this, the eleventh annual convention, is largely due to the efforts of our President, M. J. Blish, our Secretary, R. K. Durham, the Program Committee, and the local Committee on Arrangements, therefore

BE IT RESOLVED, That we express the appreciation of the Association to Messrs. Blish, Durham, Clark, Lawellin, Swanson, Alexander, Wilkins and Mange.

BE IT FURTHER RESOLVED, That our Secretary be instructed to convey to the management of Hotel Statler, our sincere thanks for the excellent accommodations and service and the splendid spirit in which this has been rendered.

BE IT FURTHER RESOLVED, That we express our appreciation to Washington University for the privilege of holding part of our sessions at their institution; to the American Baking Company, the Nafziger Baking Company, the Anheuser-Busch Brewery and the Ralston Purina Feed Mill Company, for affording us the opportunity to visit their plants; to the Allied Trades for the entertainment provided.

BE IT FURTHER RESOLVED, That we enjoy the co-operative spirit evidenced by the Association of Operative Millers, and sincerely hope that the cordial relations now existing between this Association and ours, may continue for all time.

BE IT FURTHER RESOLVED, That the Secretary be instructed to convey to the family of the late Theodore F. Ismert, former president of the Ismert-Hincke Milling Company, and honorary member of the American Association of Cereal Chemists, who died at his home on September 4, 1924, our recognition of the distinct loss which the Association has sustained through his death.

BE IT ALSO RESOLVED, That the Secretary be instructed to spread upon the minutes of this convention, a copy of these resolutions, and to furnish additional copies to the parties herein mentioned.

Respectfully submitted,

COMMITTEE ON RESOLUTIONS,

LESLIE R. OLSEN, *Chairman*

L. H. BAILEY

A. A. JONES

Moved report be accepted. Seconded, carried.

Report of Committee on Standardization of Methods, C. E. Mangels, chairman; M. R. Warren, protein investigation and C. B. Kress, protein investigation.

Moved by R. J. Clark that report be accepted. Lost.

Moved that Recommendations of Methods Committee be taken up and voted on separately. Seconded, carried.

Recommendations of Methods Committee.

It is recommended:

(1) That the chairman of the Methods Committee be empowered to appoint the other members of the committee. Each appointee on the committee

to be assigned a specific problem, and the number serving on the committee to be left to the discretion of the chairman.

(2) That the chairman of the Methods Committee or at least one member of the committee be in a position to attend the A. O. A. C. meeting in Washington, D. C.

Moved that recommendations 1 and 2 be accepted. Seconded, carried.

(3) That in order to secure uniformity chemists are requested to report 2 decimal places for moisture, 3 decimal places for ash, and 2 decimal places for protein. It is also understood that the last decimal place in all cases is considered only an approximation.

Moved that recommendation 3 be accepted. Seconded, carried.

(4) That on the basis of present analytical methods a tolerance between two different laboratories of .3% on moisture, when using same method, 0.02% on ash, and 0.25% on protein, when calculated to uniform moisture basis, is allowable.

Moved that recommendation 4 be accepted. Seconded, carried.

(5) That methods for moisture specify a definite time of heating rather than heating to a constant weight, and directions for cooling in desiccator be made more specific as to time.

Moved that recommendation 5 be accepted. Seconded, carried.

(6) That directions for the determination of protein be made very specific and the following provisions are tentatively recommended:

Use a 1 gram sample, place in a Kjeldahl flask of at least 500 cc. capacity, add 6.5 grams of sodium sulphate or an equivalent amount of potassium sulphate, .7 grams yellow mercuric oxide or equivalent in metallic mercury, and 25 cc. sulphuric acid. Digest for two hours at temperature sufficiently high to keep contents boiling.

Cool, dilute with 250 cc. water, add zinc, and sufficient sodium or potassium sulphide to precipitate all the mercury. Add a slight excess of strong caustic soda and distill into a sufficient quantity of standard HCl or H_2SO_4 to fix all ammonia. Use methyl red indicator.

Moved that recommendation 6 be rejected. Seconded, carried.

Moved that the average time of digestion used in the laboratory shall obtain the maximum protein content, this maximum amount of protein shall be defined as follows: That in 20% more or less time the protein obtained shall not be more than 0.05% of protein more or less.

Motion lost.

(7) That the committee study collaboratively the different methods of standardizing acids for Kjeldahl determinations

(8) That the committee study effect of temperature and time on capacity of boric acid to fix ammonia.

(9) That the committee study collaboratively the determination of viscosity in flour.

(10) That the committee study the sampling, grinding, and preparation of wheat samples for analysis, such studies to include:

(1) Comparison of different types of laboratory mills

(2) Original fineness of grinding

(3) Method of mixing after grinding

(4) Relation of moisture variation to protein results.

Moved that recommendations 7, 8, 9, and 10 be accepted. Seconded, carried.

Report of nominating committee:

Nominations for president:

L. R. Olsen, R. J. Clark, C. O. Swanson.

Nominations for vice president:

R. P. Potts, E. N. Frank, A. A. Heon, L. R. Olsen, G. L. Alexander.

Nominations for secretary-treasurer:

R. K. Durham, R. C. Sherwood, L. H. Bailey.

Nominations for editor-in-chief:

C. H. Bailey, M. J. Blish, D. A. Coleman.

Moved President instruct Secretary to wave constitution and cast unanimous ballot for Dr. Bailey as Editor-in-chief. Seconded, lost.

Amended to include entire editorial staff remain in office. Seconded, carried.

Nominations for managing editor:

C. G. Ferrari, S. J. Lawellin, H. G. Nelson.

Following officers elected:

President, Roland J. Clark

Vice president, L. R. Olsen

Secretary-treasurer, R. K. Durham

Editor-in-chief, C. H. Bailey

Managing editor, C. G. Ferrari.

New business:

Dr. Bailey moved that the executive committee is empowered to appropriate as much of the \$5.00 annual dues in excess of \$3.00 for the support of the journal, Cereal Chemistry, as appears justified in the interests of the members of the association. Nothing in this motion shall modify the action of the association in convention in 1923 in appropriating a minimum of \$3.00 of annual dues to the Cereal Chemistry fund. Seconded, carried.

Dr. Bailey moved that Editorial Board may be privileged to appoint as an associate editor a non-member of the association if such an associate editor is particularly qualified to edit a department of the journal. Seconded, carried.

Meeting adjourned by motion at 1:00 p. m.

THURSDAY, JUNE 4, 1925

Meeting called to order at 9:15 a. m. at Washington University by President Clark.

Following Auditing Committee appointed:

R. C. Sherwood, chairman; E. E. Smith, D. A. Coleman.

Moved that meeting be called to order at 8:30 a. m. instead of 9:00 a. m., June 5th, for business session. Seconded, carried.

Paper—"Ash of wheat and flour," by C. E. Foster.

Paper—"Recent Developments in the studies of the Physico-Chemical Properties of the Gluten Proteins," by C. H. Bailey.

Paper—"The effect of climatic conditions on the quality of Hard Red Spring Wheat," by C. E. Mangels.

Paper—"Some variable factors of Bread Production," by C. G. Harrel.

Paper—"Hydrogen ions and their application to mill control," by H. E. Weaver.

Recess for lunch.

Meeting reconvened at 1:30 p. m.

Paper—"Comments on use of acid calcium phosphate for improving Soft Wheat Biscuit Flours," by G. L. Alexander.

Meeting adjourned by motion at 2:30 p. m.

FRIDAY, JUNE 5, 1925

Meeting called to order at 8:30 a. m. at Statler Hotel by President Clark.
Appointment of committees:

Executive Committee: L. R. Olsen, chairman; G. L. Alexander, C. G. Harrel, L. E. Leatherrock.

Methods Committee: D. A. Coleman, chairman; C. B. Morrison, R. B. Potts, A. A. Sasse, C. O. Swanson, G. A. Shuey.

Program Committee: M. R. Warren, chairman; C. O. Swanson, J. C. King, D. A. Coleman, H. E. Weaver, E. N. Frank.

Location of convention: L. R. Olsen, chairman; A. A. Towner, M. A. Gray.

Allied Association Committee: H. E. Weaver, chairman; L. R. Olsen, C. B. Morrison, A. A. Schaal.

Publicity Committee: S. J. Lawellin, R. S. Herman, R. C. Sherwood, L. D. Whiting.

Report of Auditing Committee.

"This committee has carefully examined the books and records of Secretary-treasurer and reports them to be in good order." D. A. Coleman, chairman.

Moved that report be adopted. Seconded, carried.

Moved by Blish that constitution be so amended that the \$5.00 application fee now required be eliminated. Seconded, carried.

Moved by Coleman that Executive Committee be empowered to employ expert auditor to audit the books at any time they see fit, preferably just before the twelfth annual convention. Seconded, carried.

Moved by Blish that a committee be appointed to conduct an employment service for members. Notices of those seeking employment to be carried in Cereal Chemistry. Seconded.

Warren moved amendment that this service be free to members but fee be charged to non-members. Seconded, carried.

Motion as amended, carried.

C. B. Morrison appointed chairman—to select others.

M. D. Mize moved that state, county or city organizations of cereal chemists, which may request it of the Secretary and whose members are members of this Association, shall be recognized and considered as a subcommittee of the methods committee of this Association and the chairman of the Methods Committee shall have the right to request any collaborative work of these clubs or any information on work done by these clubs. Also no person shall be allowed membership in more than one of these clubs. Seconded, lost.

M. R. Warren moved that \$25.00 be drawn from the treasury to give present to retiring President. Seconded, carried.

Moved that committee be appointed to purchase present to be presented at this meeting. Seconded, carried.

The following committee appointed:

M. R. Warren, C. G. Harrel, C. B. Kress.

Moved that in view of the services of Dr. C. H. Bailey and Mr. C. G. Ferrari in connection with the Journal, their railroad expenses be borne by the Association. Seconded.

Amendment moved that motion include entire convention expenses of these officers. Seconded, carried.

Original motion as amended, carried.

Moved that in view of the increasing duties of the Secretary-treasurer and the importance of the proper execution of such work for the benefit of the Association, \$100.00 be set aside by the Association to be used as the Secretary-treasurer sees proper for general office work. Seconded, carried.

"Criticisms of Chemists from a Mill Manager," by D. S. Jackman.

"Science in the mill," by P. H. Lawson.

Paper—"Viscosity and Baking Quality," by E. E. Smith.

Paper—"Viscosity Studies of Nebraska Wheat Flour," by M. J. Blish and R. M. Sandstedt.

Paper—"Effect of H_2O_2 on relative viscosity of wheat and flour suspensions," by R. K. Durham.

Convention adjourned by motion.

REGISTRATION OF THE CONVENTION,
AMERICAN ASSOCIATION OF CEREAL CHEMISTS,

St. Louis, Mo., June 1 to 6, 1925

NAME	FIRM	ADDRESS
Alfen, S.....	Bureau of Chemistry.....	St. Louis, Mo.
Alexander, G. L.....	Geo. P. Plant Milling Co.....	St. Louis, Mo.
Armstrong, C. A.....	Igleheart Milling Co.....	Evansville, Ind.
Bailey, C. H.....	Biscuit and Cracker Assn.....	Chicago, Ill.
Bailey, L. H.....	Bureau of Chemistry.....	Washington, D. C.
Barker, H. C.....	Wells-Abbott-Nieman	Schuyler, Neb.
Bergman, W. L.....	Industrial Appliance Co.....	Chicago, Ill.
Blish, M. J.....	Agricultural Experiment Station.....	Lincoln, Neb.
Bohn, R. M.....	W. E. Long Co.....	Chicago, Ill.
Boyer, D. L.....	Provident Chemical Works.....	St. Louis, Mo.
Bulena, H. G.....	Globe Grain and Milling Co.....	Los Angeles, Calif.
Curtis, A. E.....	Midland Flour Mill Company.....	Kansas City, Mo.
Coleman, D. A.....	United States Department of Agriculture	Washington, D. C.
Carr, F.....	South-Western Laboratory.....	Kansas City, Mo.
Camery, W. D.....	Meyer Company.....	St. Louis, Mo.
Carl, T. E.....	Fleischman Company.....	New York City, N. Y.
Clark, R. J.....	Goers Flour Mills Co.....	Newton, Kan.
Collatz, F. A.....	American Diamalt.....	Cincinnati, Ohio
Dunlap, F. L.....	Industrial Appliance Co.....	Chicago, Ill.
Durham, R. K.....	Rodney Milling Co.....	Kansas City, Mo.
Epstein, W. G.....	B. A. Eckhart Milling Co.....	Chicago, Ill.
Evans, N. C.....	National Miller.....	Chicago, Ill.
Fair, B. H.....	Noblesville Milling Co.....	Noblesville, Ind.
Frey, W. L.....	Proctor & Gamble.....	Cincinnati, Ohio
Frye, R.....	Kansas Flour Mills.....	Kansas City, Mo.
Fuller, G. O.....	Acme Milling Co.....	Oklahoma City, Okla.
Ferguson, H. K.....	American Miller.....	Chicago, Ill.

NAME	FIRM	ADDRESS
Ferrari, C. G.	Dunwoody Institute	Minneapolis, Minn.
Fischer, V. E.	Standard Tilton Co.	Alton, Ill.
Fitz, L. A.	Fleischmann Company	New York City, N. Y.
Fletcher, T. G.	Wichita Mill and Elevator Co.	Wichita Falls, Texas
Flick, H.	Washburn-Crosby	Louisville, Ky.
Frank, E. N.	Washburn-Crosby Co.	Minneapolis, Minn.
Gillet, J. M.	Victor Chemical Works	Chicago, Ill.
Glasgow, W. E.	Cargill Elevator Co.	Minneapolis, Minn.
Gray, M. A.	Pillsbury Flour Mills Co.	Minneapolis, Minn.
Grey, G. B.	Nafziger Baking Co.	Kansas City, Mo.
Harrel, C. G.	Continental Baking Co.	Chicago, Ill.
Harper, O. W.	Shellabarger Mill and Elevator Co.	Salina, Kan.
Heil, Henry	Heil Chemical Co.	St. Louis, Mo.
Herman, R. S.	Ismert-Hincke	Kansas City, Mo.
Hagan, J. A.	Lexington Roller Mills Co.	Lexington, Ky.
Howard, G. L.	Moore & Lowry Flour Mills	Kansas City, Mo.
Hertwig, R.	Bureau of Washington	Washington, D. C.
Howerton, J. L.	Provident Chemical Works	St. Louis, Mo.
Ingels, B. D.	Wallace & Tierman Co.	Newark, N. J.
Jones, A. A.	Hoyland Flour Mills	Kansas City, Mo.
Kress, C. B.	Sperry Flour Co.	San Francisco, Calif.
Kane, E. L.	Commercial Milling Co.	Detroit, Mich.
Kelley, E. E.	Imperial Flour Mills	Wichita, Kan.
King, J. C.	Kansas State Laboratory	Kansas City, Mo.
Kolb, P. V.	Provident Chemical Works	St. Louis, Mo.
Lawellin, S. J.	Wallace & Tierman Co.	New Ulm, Minn.
Leatherock, L. E.	Kansas Milling Co.	Wichita, Kan.
Lentz, H. L.	Robinson Milling Co.	Salina, Kan.
Liggett, H. G. Jr.	Colorado Milling and Elevator Co.	Denver, Colo.
Little, J. T.	Crete University	Omaha, Neb.
Logue, P.	Provident Chemical Works	St. Louis, Mo.
Mange, C. E.	Walter Fruend Bread Co.	St. Louis, Mo.
Mangels, C. E.	N. D. Agricultural College	Fargo, N. D.
McLaren, L. H.	Board of Trade	Kansas City, Mo.
Minton, P. E.	Wallace & Tierman Co.	Indianapolis, Ind.
Mitchell, L. C.	United States Food Inspection	St. Louis, Mo.
Morrison, C. B.	American Institute of Baking	Chicago, Ill.
Mudge, J. B.	Fleischmann Yeast Co.	New York City, N. Y.
Mullin, Wm. J.	Novadel & Van der Lande	Buffalo, N. Y.
Olsen, L. R.	International Milling Co.	Minneapolis, Minn.
Osborne, O. S.	Abilene Flour Mills	Abilene, Kan.
Overall, A. R.	Nashville Roller Mills	Nashville, Tenn.
Oppen, C. O.	Lawrenceberg Roller Mills Co.	Lawrenceberg, Ind.
Paterson, R. L.	St. Joseph Testing Laboratory	St. Joseph, Mo.
Potts, R. B.	Wichita Flour Mills	Wichita, Kan.
Robinson, C. H.	Dominion Gov. of Agricultural	Ottawa, Kan.
Rauch, W. E.	Patterson Milling Co.	Coffeyville, Kan.
Runyon, C. G.	Linsberg Mill and Elevator Co.	Linsberg, Kan.
Ross, M. C.	A. H. Thomas Co.	Philadelphia, Pa.
Roberts, C. C.	Modern Miller	Kansas City, Mo.
Ross, Hugo	Grain Marketing Co.	Chicago, Ill.
Sanderson, W. H.	National Miller	Chicago, Ill.
Sanford, T. W.	Eagle Roller Milling Co.	New Ulm, Minn.
Shipley, V.	National Milling Co.	Toledo, Ohio

NAME	FIRM	ADDRESS
Shollenberger, J. H.	Department of Agriculture	Washington, D. C.
Schaal, A. A.	Biscuit and Cracker Mfg. Assn.	Chicago, Ill.
Smith, E. E.	F. W. Stock & Son	Hillsdale, Mich.
Stark, R. W.	University of Illinois	Urbana, Ill.
Stark, A. B.	Galesburg Roller Mills	Galesburg, Mo.
Spenser, Chas.	Plant Milling Co.	St. Louis, Mo.
Sherwood, R. C.	State Testing Mills	St. Paul, Minn.
Shelley, C. W.	State Grain Inspection Department	Minneapolis, Minn.
Slifer, C. W.	Industrial Appliance Co.	Chicago, Ill.
Stroud, W. H.	Soft Wheat Millers Assn.	Nashville, Tenn.
Swanson, C. O.	Kansas State Agricultural College	Manhattan, Kan.
Thompson, H. L.	Crete Mills	Crete, Neb.
Tibbling, E. F.	Washburn-Crosby Co.	Kansas City, Mo.
Titus, Zorada	Page Mill Co.	Topeka, Kan.
Towner, A. A.	Red Star Milling Co.	Wichita, Kan.
Veatch, L.	H. D. Lee Milling Co.	Salina, Kan.
Warning, W. G.	Provident Chemical Works	St. Louis, Mo.
Warren, M. R.	Quaker Oats Co.	Cedar Rapids, Iowa
Webb, James	Cogle & Hill Milling Co.	Carthage, Mo.
Ward, Clarence	Hunter Milling Co.	Wellington, Kan.
Weaver, H. E.	Larabee Flour Mills	St. Joseph, Mo.
Wilkins, S. D.	Ralston Purina Co.	St. Louis, Mo.
Winkler, H. W.	Kehlor Flour Mills	St. Louis, Mo.
Whiting, L. D.	Ballard & Ballard	Louisville, Ky.
Whittaker, A. K.	Davis Flour Co.	Detroit, Mich.
Wood, J. C.	Scott County Milling Co.	Sikeston, Mo.
Woolsey, F.	Omaha Flour Mills	Omaha, Neb.
De Wysocki, Victor	Shredded Wheat Co.	Niagara Falls, N. Y.

GREETINGS

Fellow A. A. C. C. Members:

Because of the distance between us I want to use this means of shaking hands with each member of the American Association of Cereal Chemists. Many of us shook (and perspired) in St. Louis; but some could not break away from Kjeldahls and test tubes, so in this brief way I wish to meet you and express the hope that we shall become better acquainted both "associationally" and personally during the coming year.

First of all I appreciate the faith and confidence which you members have placed in me for the ensuing months and in return I hope to do my bit to the best of my ability.

Now many of you are saying, "What is Clark going to do?" "Which way will he jump first?" "What will the association undertake?" These and many more questions are in your minds, so let's informally talk over some of our common problems.

As I understand the situation, I am here to render service to you. In so doing, I want the association above all else to become even a more practical organization than it has in the past; therefore, let me

emphasize the thought I mentioned in St. Louis that I am always open for criticisms and suggestions. Gossip is harmful, so write out your idea as to how the association should be run and what policies you would like to see changed or adopted. We can then discuss your thoughts.

The association work for the coming year might be divided into two general classes that within the organization and that without. First under the inside work we should all plan for a complete revision of our standard methods. The booklet of methods in use at present was published in 1922. There have been many conventions and numerous changes recommended by various committees since 1922.

It is easy to change the wording of the methods according to the recommendations of the committees, but many points need careful collaborative study. If we are called upon, let's boost such work by prompt replies.

We should not overlook the important work of the baking committee. In view of the fine start this committee made last year, we can doubtless add a baking procedure to our revised booklet of methods at the close of this year's work. Why not, while we are making a careful check on methods of all kinds, draw up a form for laboratory reports which will cover at least the important and essential items of our daily reports?

Secondly, I believe we must have vision not only as an association but individually. It is a known fact that we may look the world over for happiness and, if it is not within us, we look in vain. This is equally true with the association standing. If we expect to improve as an organization we must improve as individuals. Our association will grow as strong as its weakest member. One lax chemist injures the entire profession and draws more attention than an entire convention of accurate workers. To be concrete, in collaborative check work both in the association and in the various local clubs let's give the name of the chemist making the analysis. This will keep us awake or weed us out as inefficient.

The association officers are working on plans for several future committees which will help us improve ourselves. One of these committees, that on employment, has been formed and has started to work. As short courses are announced during the year, let us avail ourselves of an opportunity to refresh our minds and keep in step with advancements. As we improve ourselves through the advantages offered by the association and through our personal efforts we can sell ourselves at a higher price, thereby giving our organization a higher standing. Let us, therefore, look to ourselves first.

Now a word about the outside touches of the association. First we need publicity. We, as an association, are rendering the industry a service. The trade journals and papers have given us wonderful support but they are handicapped in trying to translate our technical work, our technical articles in "cereal chemistry" and our technical actions into language the layman can understand. We are many times misquoted and poorly understood. To help in this translating the publicity committee was formed. Let's bring this same idea close home so each one of us can work on this committee. Your firm paid your St. Louis expenses. How many of us made a written report to our managers concerning the high lights in the convention? If not, what kind of an idea is the manager justified in holding against us? Again, how many of us have placed "Member of the A. A. C. C." on our laboratory reports and stationery? It would help.

Secondly, we need more members. Our membership embraces mill, bakery, research, and control chemists as well as college professors. Our field therefore is broad. Why not adopt a slogan for the year of "every one get one." As an inducement to this end the St. Louis convention abolished the entrance fee. The secretary has plenty of membership application blanks.

Third, we should co-operate with our allied organizations in both the milling and baking fields. So many problems arising in our daily work touch or effect one of these organizations that mutual co-operation hastens a much more successful solution than if one body alone undertook the work.

In conclusion, as I again thank you for the honor you have given me, let me say that throughout the year's work, whether on the inside for our mutual self-improvement or on the outside for the building of our relations with others I welcome constructive suggestions, so feel free to write. As the announcements come from time to time of committee appointments and the work which will be undertaken, try to help the committee in its work. Let's all pull together.

Indeed, I am glad to have met you.

ROWLAND J. CLARK, *President.*